MINERAL RESOURCES OF ALASKA, 1915.

By ALFRED H. BROOKS and others.

PREFACE.

By ALFRED H. BROOKS.

This volume is the twelfth 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 in previous years, the writer is under great obligations to many residents of the Territory for valuable data. Those who have thus aided him include many mine operators, engineers, prospectors, Federal officials, and officers of banks and of transportation and commercial companies. It is impossible to enumerate all who have contributed information, but special acknowledgment should be made to the Director of the Mint; the Wells-Fargo Express Co.; the Alaska

[1] U. S. Geol. Survey Bulls. 259, 284, 314, 345, 379, 442, 480, 520, 542, 592, 622, and 642.

Mexican Gold Mining Co., Alaska United Gold Mining Co., and Alaska Treadwell Gold Mining Co., of Treadwell; Arthur G. Thompson, of Katalla; George M. Esterly, of Nizina; Stephen Birch, of Kennicott; James G. Godfrey, of McCarthy; John A. Rowe, of Chitina; George R. Goshaw, of Chisana; T. E. Phillips, of Jack Wade; John L. Abrams, of Fortymile; J. J. Hillard, of Eagle; Frank A. Reynolds, of Circle; R. C. Wood, J. A. Fairburn, George Hutchison, A. Bruning, American Bank, First National Bank, Albert Johnson, R. J. Sommers, and C. W. Joynt, of Fairbanks; Jay Livengood, N. R. Hudson, Harry Patterson, C. P. Keen, W. Allmark, and J. P. Norich, of Livengood; George W. Ledger and W. B. Ballou, of Rampart; Adolph Bock and S. S. Rowell, of Hot Springs; A. J. Day, of Ruby; Alexander Cameron, of Poorman; W. A. Vinal and H. F. Fothergill, of Ophir; C. P. Wood, of Iditarod; J. C. Felix, of Hughes; O. R. Williams, of Nolan; Frank H. Waskey, of Marshall; Henry Howard, of Aniak; J. W. Felder, of Bethel; William Loiselle, of Quinhagak; R. W. J. Reed, of Nome; G. A. Adams, of Council; D. L. McDonald, of Candle; F. H. Thomas, of Shelton; Lars Gunderson, of Golovin; M. F. Moran and Lewis Lloyd, of Shungnak; and Edward Wood, of Kiana.

The arrangement and manner of treatment in this volume are the same as in those previously issued. First a paper describing the general status of the mining industry is presented, followed by those treating of special districts, arranged geographically from south to north. This bulletin contains twelve papers by nine 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 economic geology of certain districts. In the geologic papers emphasis is laid on the conclusions having 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 1915 in Alaska surveys and investigations. The length of the field season varied from three to eight months, being determined both by the needs of the work and by the climatic conditions prevailing in different parts of the Territory. The parties included 10 geologists, 4 topographers, 1 engineer, and 30 packers, cooks, and other auxiliaries. In addition to these, some gage readers were employed, who gave only part of their time to the work. Six of the parties were engaged in geologic work, 2 in both geologic and topographic surveys, 2 in topographic surveys, and 2 in investigating water resources.

The area covered by geologic reconnaissance surveys, on a scale of 1:250,000 (4 miles to the inch), was 10,700 square miles; by detailed geologic surveys, on a scale of 1:62,500 (1 mile to the inch), 200 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the principal mining districts, the results of which can not be presented areally. About 10,400 square miles were covered by topographic reconnaissance surveys, on a scale of 1:250,000 (4 miles to the inch), and 12.5 square miles by detailed topographic surveys, on a scale of 1:24,000 (2.64 miles to the inch).

In cooperation with the Forest Service the investigation of water powers of southeastern Alaska was begun in May, and during the summer eight automatic gaging stations were installed and maintained until the close of the year. Records of discharge were also kept at another station.

To state the work geographically, three parties worked in southeastern Alaska, one in the Copper River basin, one on Prince William Sound, two in the Cook Inlet-Susitna region, three in the Yukon basin, one in the Yukon-Kuskokwim region, while one was engaged in general investigations which included southeastern Alaska, the Yukon basin, and Seward Peninsula.

Among the important results of the year was a reconnaissance survey of the upper Chitina basin, the completion of the detailed

geologic survey of the Valdez district, the exploration of the Cosna-Nowitna region, and the tying together of the reconnaissance surveys of the Ruby, Innoko, and Iditarod districts.

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 $11,000 from last year's appropriation was expended in equipping the 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. The "general investigations" include, among 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 1916.

Approximate geographic distribution of appropriation for Alaska investigations, 1915.

Southeastern Alaska	$16,300
Copper River	10,400
Prince William Sound	5,000
Cook Inlet region	13,500
Yukon and Kuskokwim basins	40,500
General investigations	8,300
To be allotted to field work, 1916	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, 1915.

Geologic reconnaissance surveys	$28,000
Detailed geologic surveys	3,800
Special geologic investigations	9,600
Reconnaissance topographic surveys	26,000
Detailed topographic surveys	3,000
Water-resource investigations	5,000
Collection of mineral statistics	1,300
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	17,300
To be allotted to field work, 1916	6,000
	100,000

Allotments for salaries and field expenses, 1915.

Scientific and technical salaries	$35,918
Field expenses	42,332
Clerical and other office and miscellaneous expenses	15,750
To be allotted to field work, 1916	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, 1898–1915.

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
	1,361,189	73,200	94,435	4,596	51,680	137,280	3,664	453	74	.....
Percentage of total area of Alaska	.....	12.48	16.10	0.78	8.81	23.41	0.62	.....	.....	.....

[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 9, when he started for Alaska. He held a conference with Mr. Canfield at Ketchikan, and devoted 10 days to the study of the geology and mineral resources

of the Iditarod district, five days to the Hot Springs district, and sixteen days to the Fairbanks district. He returned to Washington October 14.

During the calendar year 1915 the writer devoted 46 days of his time in the office to geologic studies, 24 days to writing the progress report, 18 days to reading and revising manuscripts, 15 days to mineral statistics, 15 days to work of various committees, 9 days to field plans, and 8 days to preparation of the annual press bulletin on mining in Alaska.

To G. A. Waring was assigned the task of making a reconnaissance of the more accessible mineral springs of Alaska. He carried on field work in southeastern Alaska from June 15 to July 2, in the Yukon basin from July 10 to August 17, and in Seward Peninsula from August 28 to September 9. During this time he investigated 18 hot springs and 5 other springs and collected 27 samples of surface waters. A report of results has been submitted for publication.[1]

G. C. Martin and A. G. Maddren were engaged the entire year in office work. This respite from field work was necessary owing to the accumulation of a large amount of field data that had not been completely worked up. Mr. Martin was engaged chiefly in continuing his studies of the Mesozoic stratigraphy of Alaska, and Mr. Maddren was employed in preparing reports on the lower Kuskokwim region and on the international boundary region of northeastern Alaska.

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.

SOUTHEASTERN ALASKA.

The detailed topographic survey of the region adjacent to Juneau was continued by D. C. Witherspoon. Field work was begun on May 12 and continued, so far as weather permitted, until October 7. The large scale adopted for this base map (1 : 24,000, or about 2.64 inches to the mile), the rugged character of the country, and the vegetation all combine to make the work exceedingly difficult. In spite of the adverse conditions Mr. Witherspoon completed the mapping of 12.5 square miles. He also occupied 16 triangulation stations, ran 3 miles of levels, and set two permanent bench marks.

[1] Waring, G. A., Mineral springs of Alaska, with a report on the quality of surface waters by R. B. Dole and A. G. Chambers: U. S. Geol. Survey Water-Supply Paper 418 (in preparation).

The systematic geologic survey of the Ketchikan district, begun in 1913 but interrupted in 1914, was continued in 1915 by Theodore Chapin. Field work was begun on May 16 and continued until October 23. A gasoline launch was used for transportation, and about 420 square miles was covered, besides which special investigations of mineral resources were made. Some of the results are summarized elsewhere in this volume.

Under a cooperative agreement with the Forest Service the investigation of the water powers of southeastern Alaska was begun in 1915. G. H. Canfield, who had charge of this work, established his headquarters at Ketchikan in May and continued the water measurements throughout the rest of the year. Eight automatic gaging stations and one other station were installed, in addition to which many miscellaneous measurements were made. Records of stream flow will have to be obtained through a period of years before accurate data on run-off are available.

Meanwhile the records thus far obtained are not without value and are summarized elsewhere in this volume. Many members of the Forest Service have aided in this work, but special acknowledgment should be made to William G. Weigle, supervisor at Ketchikan, and to Leonard Lundgren, district engineer at Portland, Oreg.

COPPER RIVER REGION.

Though much the larger part of the Copper River basin had been covered by reconnaissance surveys and some detailed geologic surveys had been made, there still remained a considerable area in the upper Chitina basin, which was geologically unknown. F. H. Moffit, assisted by R. M. Overbeck, was detailed to this investigation. A journey was made with pack train up the north side of the Chitina Valley to a point within 10 miles of the international boundary. Field work began on June 20 and ended September 25, and a geologic reconnaissance of about 900 square miles was completed. The topographic map made by the International Boundary Commission was used as a base and was supplemented by topographic reconnaissance surveys of an adjacent area of about 360 square miles. The economic results are summarized in this volume, and the complete report is in preparation.

PRINCE WILLIAM SOUND.

The detailed geologic survey and study of mineral resources of the Port Valdez district, begun in 1914, was completed in 1915 by B. L. Johnson. He began field work on June 5 and continued it until October 25. His report is now in preparation.

COOK INLET-SUSITNA REGION.

The construction of the Government railroad from Seward to Fairbanks has led to a demand for information about the tributary regions. Most of these had been mapped and investigated in previous years, but there were some areas east of Knik Arm and in the Talkeetna Mountains about which little was known. Two parties were detailed to explore those regions.

J. W. Bagley devoted the early part of the season to extending the topographic reconnaissance north of the previously mapped areas in the Talkeetna Mountains over an area of 835 square miles. He also surveyed an area of 150 square miles in the Knik and Turnagain Arm region. Pack-train transportation was used, and field work began on June 6 and continued until September 5. Mr. Bagley's surveys were much hampered by the smoke of forest fires in the early part of the season, and later he lost nearly three weeks because of the nondelivery of some supplies, owing to an accident that was caused by no fault of the contractor.

S. R. Capps, with a pack train and two men, studied the geology of the Knik and Turnagain Arm region, investigating the geology of an area of about 1,200 square miles. From June 14 to September 12 was devoted to fieldwork, but about a week of this time was spent in investigating the mining developments of the Willow Creek district. The results of Mr. Capps's work are presented elsewhere in this volume.

YUKON AND KUSKOKWIM BASINS.

The general features of the geology of the upper part of the Yukon basin in Alaska are fairly well known through the various reconnaissance surveys that have been made in the past. At best, however, the stratigraphic sequence and structure have been determined only on broad general lines, and present knowledge contains many gaps which are fatal to correlation. Owing to the rapid mining development a more detailed knowledge is imperative. As a preliminary measure some stratigraphic and structural studies of this region were undertaken in 1915 by Eliot Blackwelder. The work was done by a boat trip from Eagle to Circle and thence with pack train to the White Mountains, 100 miles to the southwest. The work was considerably hampered by the loss of the pack train in midsummer, but some significant stratigraphic and structural results were achieved. The return to the Yukon was made by raft down Beaver and Birch creeks, and it was thus possible to make traverses of those streams, whose courses through the flats were previously unknown. The geologic results are to be summarized in a publication now in preparation.

Before the surveys of 1915 much of the area lying between the Ruby district, on the southwest, and Tanana River, on the northeast,

was practically unknown. H. M. Eakin was assigned to the work of exploring this field. He left the mouth of Cosna River, a southern tributary of the Tanana, with a pack train on June 16 and carried a geologic and topographic exploratory survey northwest to the Nowitna. Here the horses were shot, and the party continued the journey to the Yukon on a raft, arriving there on September 3. Though he had no technical assistance, Mr. Eakin made geologic exploratory surveys of an area of 2,600 square miles and topographic surveys of an area of 3,000 square miles.

A large area was also surveyed in the region including the Ruby district on the north and Iditarod on the southwest and extending southeastward to the mouth of Takotna River, a tributary to the Kuskokwim. The northern party in this field, which included C. E. Giffin, topographic engineer in charge, with G. L. Harrington as geologist, covered some 2,400 square miles by geologic and topographic reconnaissance surveys, besides revising the old surveys of some 1,600 square miles. The traveling was done by pack train and the field season extended from June 11 to September 11. R. H. Sargent, topographic engineer, had charge of the southern party, with J. B. Mertie as geologist, and worked from June 13 to September 7. This party made topographic and geologic reconnaissance surveys of 3,520 square miles and revised the previous surveys of 490 square miles. This work was accomplished between June 13 and September 7.

COLLECTION OF STATISTICS.

The collection of statistics of precious-metal production was continued by the writer, assisted by different members of the field staff but principally by Mr. Aten, as in previous years. Mine operators have shown an increasing interest in this work by furnishing statements of mineral production. There are still some who fail to make returns, thereby decreasing 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 delinquents are chiefly placer miners, for practically all the gold and copper lode operators make annual returns on output. As has been the practice in the past, a press bulletin was issued on the first of January summarizing the estimates of mineral production and mining developments of the previous year. Though the figures on 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 they are most needed.

PUBLICATIONS.

During 1915 the Survey published one professional paper, six bulletins, and one water-supply paper relating to Alaska. Another water-supply paper was published in February, 1916. In addition, two bulletins are in press, and ten reports, including this volume, were in progress at the end of the year. Eight topographic maps were published during the year, and three others are in press.

REPORTS ISSUED.

Professional Paper 87. Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska, by C. W. Wright; including detailed geologic and topographic maps.

Bulletin 576. Geology of the Hanagita-Bremner region, Alaska, by F. H. Moffit; including topographic and geologic reconnaissance maps.

Bulletin 587. Geology and mineral resources of Kenai Peninsula, Alaska, by G. C. Martin, B. L. Johnson, and U. S. Grant; including geologic and topographic reconnaissance maps.

Bulletin 605. The Ellamar district, Alaska, by S. R. Capps and B. L. Johnson; including detailed geologic and topographic maps.

Bulletin 607. The Willow Creek district, Alaska, by S. R. Capps; including detailed geologic and topographic maps.

Bulletin 608. The Broad Pass region, Alaska, by F. H. Moffit, with sections on Quaternary deposits, igneous rocks, and glaciation by J. E. Pogue; including geologic and topographic reconnaissance maps.

Bulletin 622. Mineral resources of Alaska: Report on progress of investigations in 1914.

Water-Supply Paper 342. Surface water supply of the Yukon-Tanana region, Alaska, by C. E. Ellsworth and R. W. Davenport; including topographic reconnaissance maps.

REPORTS IN PRESS.

Water-Supply Paper 372. A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport. (Published February 4, 1916.)

The Chisana-White River district, Alaska, by S. R. Capps (Bulletin 630).

The Yukon-Koyukuk region, Alaska, by H. M. Eakin (Bulletin 631).

REPORTS IN PREPARATION.

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. Wright and C. W. Wright; including geologic reconnaissance map.

Geology of the region along the international boundary from Porcupine River to the Arctic Ocean, by A. G. Maddren; including detailed geologic map.

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

The antimony deposits of Alaska, by Alfred H. Brooks (Bulletin 649).

The mineral springs of Alaska, by G. A. Waring (Water Supply Paper 418).

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

The Lake Clark-Central Kuskokwim region, by Philip S. Smith.

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

The Nelchina-Susitna region, by Theodore Chapin.

TOPOGRAPHIC MAPS ISSUED.

General map of Alaska, by R. H. Sargent; scale, 1:500,000. Sale edition.

Port Valdez district, by J. W. Bagley and C. E. Giffin; scale, 1:62,500; contour interval 50 feet. Sale edition.

Index map of Alaska; including list of publications; scale, 1:5,000,000.

Kenai Peninsula, by R. H. Sargent and J. W. Bagley; scale, 1:250,000; contour interval 200 feet. (Plate II, Bulletin 587.)

Moose Pass and vicinity, by J. W. Bagley; scale, 1:62,500; contour interval 50 feet. (Plate IV, Bulletin 587.)

Willow Creek district, by C. E. Giffin; scale, 1:62,500; contour interval 100 feet. (Plate II, Bulletin 607.)

Ellamar district, by R. H. Sargent and C. E. Giffin; scale, 1:62,500; contour interval 100 feet. (Plate I, Bulletin 605.)

Broad Pass region, by J. W. Bagley; scale 1:250,000; contour interval 200 feet. (Plate I, Bulletin 608.)

TOPOGRAPHIC MAPS IN PRESS.

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

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

Yukon-Koyukuk region, by H. M. Eakin; scale, 1:500,000; contour interval 400 feet. (Plate I, Bulletin 631.)

THE ALASKAN MINING INDUSTRY IN 1915.

By ALFRED H. BROOKS.

GENERAL FEATURES.

The Alaskan mining industry as a whole was more prosperous in 1915 than in any previous year. This is indicated by the value of the total mineral output, which was $32,854,229, compared with $19,065,666 for 1914. The highest value for any previous year was in 1906, when Alaska produced $23,378,428 worth of minerals, but this was at a time when the bonanza placers of Fairbanks and Nome were yielding their greatest returns. Though the high value of the mineral production of 1915 was due for the most part to an enormous copper output, which was more than four times that of the previous year, yet the mining of gold, silver, and other mineral products also increased. The gold output of the placer mines was less than in the previous year, but this decrease was more than made up by the increase in gold output of the lode mines.

The enormous expansion of the copper-mining industry was directly due to the high price of copper, yet it should be noted that this expansion was possible only because of the large developments that have been under way for several years. It augurs well for the future of the industry that the Alaska copper mines are now sufficiently developed to take advantage of the market conditions of last year by producing so large a tonnage.

There were also during 1915 marked advances in the Alaskan auriferous lode mining industry. As in previous years, the gain was made principally in southeastern Alaska and especially in the Juneau district, though progress was also made in some of the other fields. The inland gold-lode camps are, however, as yet too isolated to permit extensive lode development, which must await the completion of railroads.

Most of the important placer camps are also in the inland region, and these have not yet reacted to the stimulus of railroad construction. Some of the smaller placer camps made notable gains in output, as compared with the previous year, yet these gains were more than offset by the decline in production from some of the more important Yukon districts. There are in the interior large areas of

gold-bearing gravel whose values are too low to permit profitable exploitation under the present high operating costs. Until cheaper transportation and fuel lessen these costs the placer output will probably continue to decline.

The high prices of tin, antimony, tungsten, and other metals stimulated the search for and development of deposits containing these minerals. Besides the tin production, which was about the same as in previous years, during 1915 considerable antimony ore was shipped from Fairbanks and Nome—the first antimony to be produced in Alaska. In the Fairbanks district the development of a vein carrying tungsten (scheelite) was begun.

Some investigations and preparations were made for the mining of high-grade Alaska coal under the new leasing law. A little lignitic coal was mined under the permit system provided by this law, but as yet no large coal-mining enterprises have been begun. With the development of the coal fields which is now assured the metalliferous mining industry will receive a great stimulus.

In addition to the minerals mentioned above, marble, gypsum, barite, and petroleum were produced on about the same scale as in previous years. Some development work was done on deposits of molybdenite, chromic iron ore, and graphite, but so far as known these minerals were not produced on a commercial scale.

The statistics for Alaska's mineral production in 1914 and 1915 are given in the subjoined table. The output of marble, gypsum, petroleum, barite, and garnet is given as a single item because a separate listing might reveal the production of individual properties.

Mineral output of Alaska, 1914 and 1915.

	1914		1915		Increase in 1915.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	762,596	$15,764,259	807,966	$16,702,144	45,370	$937,885
Silver.....do....	394,805	218,327	1,071,782	543,393	676,977	325,066
Copper.....pounds..	21,450,628	2,852,934	86,509,312	15,139,129	65,058,684	12,286,195
Tin.....tons of metallic tin..	104	66,560	102	78,846	[a] 2	12,286
Antimony....tons of crude ore..	.....	.....	833	74,000	833	74,000
Lead.....short tons..	28	1,344	437	41,118	409	39,774
Coal.....do....	.....	.....	1,400	3,300	1,400	3,300
Marble, gypsum, petroleum, etc.	.....	162,242	.....	272,299	.....	110,057
		19,065,666		32,854,229		13,788,563

[a] Decrease.

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 more than $300,000,000. This output, by years and substances, is summarized in the following table:

Value of total mineral production of Alaska, 1880–1915.

By years.		By years.		By substances.	
1880–1890	$4,686,714	1904	$9,569,715	Gold	$260,858,943
1891	916,920	1905	16,480,762	Silver	2,821,911
1892	1,098,400	1906	23,378,428	Copper	34,919,581
1893	1,051,610	1907	20,850,235	Tin	458,852
1894	1,312,567	1908	20,145,632	Antimony	74,000
1895	2,388,042	1909	21,146,953	Lead	108,260
1896	2,981,877	1910	16,887,244	Coal	365,833
1897	2,540,401	1911	20,691,241	Marble, gypsum, petroleum, etc.	1,346,371
1898	2,587,815	1912	22,536,849		300,953,751
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		300,953,751		
1903	8,944,134				

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.

Gold, silver, and copper produced in Alaska, 1880–1915.

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	9,728	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	52,245	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	538,695
1911	815,276	16,853,256	460,231	243,923	27,267,878	3,408,485
1912	829,455	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
	12,619,050	260,858,943	4,923,288	2,821,911	219,913,375	34,919,581

In the subjoined table the total gold production is distributed according to districts so far as the information at hand will permit. The error in distribution of total production previous to the year 1905, when the systematic collection of statistics on Alaska's mineral output was begun, is believed to be less than 10 per cent. Complete statistical returns from all producers are not even now available so that there is probably still some error in the distribution of the totals to the various districts. This error, however, is believed to be less than 3 per cent, and it is hoped that in the future it may be eliminated altogether.

The gold produced in the Pacific coast belt is derived chiefly from lodes in southeastern Alaska and the Prince William Sound region, but includes a small output from gold placers. Previous to 1885 the placers of the Juneau district yielded considerable gold, and since 1899 the Porcupine placer district, in southeastern Alaska, has been a small producer. The beach placers along the Pacific seaboard have been worked spasmodically since about 1888.

Up to 1909 all the gold from the Copper River and Cook Inlet region was derived from gold placers; since then there has been a considerable output from the auriferous lodes of Willow Creek and a smaller output from those of Kenai Peninsula. The gold output of Seward Peninsula is practically all derived from placers, though there has been a little lode mining. Since 1910 there has been a small lode production from the Fairbanks district, which in 1915 amounted to about 7.5 per cent of the total.

Some gold has been recovered each year since 1910 from placers in the lower Kuskokwim basin. In the table which follows, this is included in the output of the Yukon basin. It should be noted that the gold output credited to the Yukon is only that from the Alaska camps and of course does not include that of the Klondike and other Canadian districts.

Value of gold produced in Alaska, with approximate distribution, 1880–1915.

Year.	Pacific coast belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula and northwestern Alaska.	Total.
1880	$20,000				$20,000
1881	40,000				40,000
1882	150,000				150,000
1883	300,000		$1,000		301,000
1884	200,000		1,000		201,000
1885	275,000		25,000		300,000
1886	416,000		30,000		446,000
1887	645,000		30,000		675,000
1888	815,000		35,000		850,000
1889	860,000		40,000		900,000
1890	712,000		50,000		762,000
1891	800,000		100,000		900,000
1892	970,000		110,000		1,080,000
1893	838,000		200,000		1,038,000
1894	882,000		400,000		1,282,000
1895	1,569,500	$50,000	709,000		2,328,500

Value of gold produced in Alaska, with approximate distribution, 1880–1915—Contd.

Year.	Pacific coast belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula and northwestern Alaska.	Total.
1896	$1,941,000	$120,000	$800,000	.....	$2,861,000
1897	1,799,500	175,000	450,000	$15,000	2,439,500
1898	1,892,000	150,000	400,000	75,000	2,517,000
1899	2,152,000	150,000	500,000	2,800,000	5,602,000
1900	2,606,000	160,000	650,000	4,750,000	8,166,000
1901	2,072,000	180,000	550,000	4,130,700	6,932,700
1902	2,546,600	375,000	800,000	4,561,800	8,283,400
1903	2,843,000	375,000	1,000,000	4,465,600	8,683,600
1904	3,195,400	500,000	1,300,000	4,164,600	9,160,000
1905	3,430,000	500,000	6,900,000	4,800,000	15,630,000
1906	3,454,794	332,000	10,750,000	7,500,000	22,036,794
1907	2,891,743	275,000	9,183,000	7,000,000	19,349,743
1908	3,448,318	401,500	10,323,000	5,120,000	19,292,818
1909	4,264,716	265,000	[a] 11,580,000	4,302,000	20,411,716
1910	4,182,730	351,630	[a] 8,062,389	3,530,000	16,126,749
1911	4,265,573	313,538	[a] 9,139,145	3,135,000	16,853,256
1912	4,904,753	358,401	[a] 8,857,797	3,025,000	17,145,951
1913	4,529,529	378,643	[a] 8,183,641	2,535,000	15,626,813
1914	4,538,157	597,681	[a] 7,895,421	2,735,000	15,764,259
1915	5,808,978	605,390	[a] 7,367,776	2,920,000	16,702,144
	76,259,291	6,613,783	106,423,169	71,562,700	260,858,943

[a] Includes a small proportion from the Kuskokwim basin.

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 in Alaska, 1880–1915.

	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*	
Siliceous ores	3,558,376	$73,558,164	986,188	$658,843
Copper ores	53,588	1,107,787	2,360,187	1,295,233
Placers	9,007,086	186,192,992	1,576,913	867,835
	12,619,050	260,858,943	4,923,288	2,821,911

The above table shows that about 29 per cent of the total gold production of Alaska has been obtained from the lode mines. In 1915 the lode-gold production was 38 per cent; in 1914, 32 per cent;

in 1913, 31.6 per cent; and in 1912, 29 per cent. These figures indicate a gradual transition from placer to lode mining. In the following table the production of precious metals in 1915 has been distributed as to sources:

Sources of gold, silver, and copper in Alaska, 1915.

	Total quantity.	Gold.		Silver.		Copper.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.	*Fine ounces*		*Fine ounces*		*Pounds.*	
Siliceous ores	3,020,607	293,588.99	$6,069,023	91,341	$46,310	.....	.....
Copper ores	369,600	7,407.23	153,121	897,839	455,204	86,509,312	$15,139,129
Placers	.....	506,970.00	10,480,000	82,602	41,879	.....	.....
	3,390,207	807,996.22	16,702,144	1,071,782	543,393	86,509,312	15,139,129

Twenty-eight gold-lode mines, including several properties that made only small outputs, were operated the whole or a part of the year 1915 in Alaska, the same number as in 1914. Work was also done on many gold prospects, some of which produced a little gold. Of the producing mines thirteen were in southeastern Alaska, five on Prince William Sound, four in Kenai Peninsula, three in the Willow Creek district, and three in the Fairbanks district. In 1914 the average value of the gold and silver contents for all the ores mined was $2.79 a ton; the average for 1915 was $2.02.

Thirteen copper mines were operated in Alaska for a whole or a part of the year 1915, compared with six in 1914. Of these, six were in the Ketchikan district, four on Prince William Sound, and three in the Kotsina-Chitina district. The average copper content of the ore was 11.7 per cent and the value of the gold and silver recovered about $1.65 to the ton. The average for 1914 was 6.98 per cent of copper and $2.04 to the ton in gold and silver.

It is estimated by Sumner Smith, the Federal mine inspector for the Territory of Alaska, that during the fiscal year ending June 30, 1915, 4,400 men were engaged in lode mining.[1] Though this figure represents the fiscal and not the calendar year, it serves to indicate approximately the number of men employed in 1915.

The value of the placer gold produced in 1915 was $10,480,000; in 1914 it was $10,730,000. Compared with the previous year there was a decrease in the placer-gold output from the Ruby, Hot Springs, Fairbanks, and Chisana districts and an increase from the Seward Peninsula, Koyukuk, Circle, and Nizina districts, as well as from some of the smaller camps. It is estimated that about 700 placer mines were operated in 1915, but many for only a part of the season; the number was 730 in 1914. About 4,575 men were engaged in

[1] Bur. Mines Fifth Ann. Rept., p. 54, 1915.

productive placer mining, most of them for only a small part of the year. In addition at least 500 men were engaged in prospecting and other nonproductive work relating to placer mining.

No new placer districts were discovered in 1915, though new ground was opened up in regions previously known to be gold bearing. The most noteworthy of these operations was the development of placers in the Tolovana district, which is now productive. Some placers were also developed on Dime Creek, in the southeastern part of Seward Peninsula and on Canyon Creek, in the lower Kuskokwim region.

In accordance with past practice a table is given here to show approximately the total bulk of gravel mined annually in Alaska and the value of the gold recovered. This table is based 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 Alaska placer mines and value of gold recovered, 1908–1915.

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	1912	7,050,000	$1.70
1909	4,418,000	3.66	1913	6,800,000	1.57
1910	4,036,000	2.97	1914	8,500,000	1.26
1911	5,790,000	2.17	1915	8,100,000	1.29

The increase in value of gold recovered per cubic yard from $1.26 in 1914 to $1.29 in 1915, as shown in the above table, is a reflection of the fact that the dredging industry of the Seward Peninsula has declined somewhat. This increase, though very slight, is significant as being the first in the eight years shown in the table, improved methods of mining having previously gradually reduced the average recovery per cubic yard. In other words, the larger plants have made it possible to mine placers of lesser value. It is not to be supposed, however, that the minimum average recovery has yet been reached, for the value of $1.29 a cubic yard is many times the average recovery of placer mining in the States.

Thirty-five gold dredges were operated in Alaska during 1915. Of these 31 were on Seward Peninsula, 2 in the Iditarod district, 1 in the Fairbanks, and 1 in the Birch Creek district. Two of the Seward Peninsula dredges were working on placers containing both gold and tin. Two dredges engaged in tin mining exclusively are not included in the above total, nor is a gold dredge which was installed and oper-

ated on Sixmile Creek, in Kenai Peninsula, for a short time during 1915.

It is estimated that the gold dredges handled 4,600,000 cubic yards of gravel and made a gold recovery worth $2,330,000. In the preceding year 42 gold dredges handled 4,450,000 cubic yards of gravel and recovered gold to the value of $2,350,000. The average gold recovery per cubic yard was therefore about 51 cents in 1915 and 50 cents in 1914. The gold dredges of Seward Peninsula made an average recovery of 35 cents a cubic yard in 1915 and 40 cents in 1914. Most of the dredges of the Yukon districts are working on placers of relatively high gold tenor, and their average recovery in 1915 was about 80 cents a yard.

The dredges of Seward Peninsula that worked full time during 1915 were operated about 100 days in the more isolated camps, while at least one near Nome was operated for 144 days. In the Alaska Yukon the dredging season, so far as determined by the few machines operated, is from 120 to 196 days. The large dredges of the Klondike, where the climatic conditions are if anything less favorable than in the lower Yukon basin, are operated for at least 180 days, and some have even worked for 270 days.

The following table, prepared by the Yukon Gold Co., summarizes the results of the first three years' work of its dredge operated on Flat Creek, in the Iditarod district:

Results obtained by Iditarod dredge of Yukon Gold Co.[a]

Season.	Began.	Ceased.	Cubic yards handled.	Yield.		Operating cost.[b]	
				Total.	Per cubic yard.	Total.	Per cubic yard.
1912	Aug. 15	Oct. 29	172,333	$404,040	$2.34	$79,114	$0.4591
1913	May 8	Nov. 25	496,756	827,420	1.67	319,560	.6433
1914	May 4	Nov. 11	668,737	739,631	1.10½	335,825	.502
			1,337,826	1,971,091	1.47	734,499	.548

[a] High yield of Iditarod dredge: Eng. and Min. Jour., vol. 99, p. 727, Apr. 24, 1915.
[b] Includes $50,000 a year depreciation.

A later statement[1] covers the work of 1915:

The Iditarod dredge in Alaska began operations on May 4 and closed down on November 17. During this operating season of 196 days the dredge handled 926,956 cubic yards for a gold return of $845,998, an average of 91.3 cents per cubic yard for the year. The average cost, including depreciation, was 38.7 cents per cubic yard, which was lower than in 1914 by 11.5 cents per cubic yard. The yardage handled in 1915 was 258,219 cubic yards greater than during the previous season. The dredge operated 91.64 per cent of the possible time and averaged 4,717 cubic yards per day. The daily output of the dredge was 1,216 yards more than during the 1911 season and was due to better dredging conditions and to improvement in the handling of sands.

[1] Perry, O. B., Dredging and hydraulicking in 1915 by Yukon Gold Co.: Eng. and Min. Jour., vol. 101, p. 550, Mar. 25, 1915.

The percentage of naturally thawed ground increased only 49,953 square yards, about 36 per cent having to be thawed by steam. Sand elevators were installed on the Iditarod dredge during the year to replace the pumps previously in use for this purpose.

In view of the importance to the Alaska placer-mining industry of the development of economic methods of dredging frozen ground, the following extracts are given from a paper by the general manager of the Yukon Gold Co.,[1] who has had very extensive experience in this form of mining:

While the short season and severe service have led to numerous improvements in detail and to increases in strength and size of the dredges and continue to offer problems which the dredge operator must meet, the greatest development in the Yukon as compared to the ordinary dredging operation has come in the handling of frozen ground. The heavy bedrock encountered on the creeks and the necessity of digging it to considerable depth to recover the gold were in themselves serious matters. No experienced dredge operator would have thought, in the beginning, that any dredge could handle the bedrock which the machines are digging to-day with comparative ease. When the business was further complicated by having large areas solidly frozen, the problem of dredging such areas at a profit became one of extreme difficulty. The results of attempts to dredge partly thawed areas and frozen bedrock were enough to show that the frozen condition must be completely changed before dredging could be successful. Necessity compelled the adoption of the present method of thawing, which is the development on a wholesale plan of the method which was in use in the drift mines in the Klondike before dredges were thought of. Preparing the ground for dredging by thawing with steam was an entirely new feature of dredge mining, and the success of the method has made millions of yards of gravel available for dredging which could not otherwise be worked at a profit.

The steam point as originally used was a short piece of ⅜-inch pipe drawn down at one end to a point, with an orifice left for the steam to escape; the other or head end had a nipple welded to it for steam-hose connection. The point with steam turned on was gradually driven into the face of the drift, then allowed to steam until the bedrock and gravel were thawed to the height of the drift. From two to six points were used in each breast, spaced from 1 to 2 feet apart. This simple operation contained the essential features of the method whereby over 3,000,000 yards of gravel are now being thawed in a season.

In the thawing operation for dredging, the points are driven from the surface down through muck and gravel and into the bedrock from 4 to 6 feet. The points are gradually lengthened in practice, first to 24 feet, then to 30, and last season were being successively driven 40 feet to bedrock. The points are made up of triple extra heavy hydraulic pipe with drop-forged head and tool-steel tip. The small boilers first used have been replaced by larger sizes until the boiler equipment now comprises eight plants with a total boiler horsepower of over 2,000. The 150-horsepower locomotive type has been adopted as the unit, and the plants usually consist of a pair or sometimes three such boilers.

The preliminary work for the season takes the following form: (1) The dredgeable area ahead of each boat is barred for frost. From the bar-hole results the naturally thawed and frozen areas are blocked out. The bar tests are checked by drilling where thought necessary. (2) Surveyors "pick up" the thawed areas, which are mapped, and planimeter measurements are made of the frozen areas. (3) The estimated course of the boat is laid out for the year and its probable position calculated for each month of the season. (4) The total square yards of frozen ground which the dredge will dig

[1] Perry, O. B., Development of dredging in the Yukon Territory: Eng. and Min. Jour., vol. 100, pp. 1042-1044, Dec. 20, 1915.

in a season is measured from the map on which the season's work is laid out, and the necessary wood for thawing is determined and its location decided.

The "sweating" of the naturally thawed ground must also be taken into account. The duty per cord, both in thawing and in sweating, to dispose of the surface frost has been determined by experience. Knowing the square yards of frozen ground to be thawed and the area of naturally thawed ground to be "sweated" and the duty per cord of fuel, the total fuel requirement for the season is a simple computation.

The thawing operation has been described elsewhere, so that I need only give the sequence of events in a normal operation: (1) Steam-line boxes are strung out by horses, if they are available, otherwise men are used; (2) gooseneck boxes and headers coupled on; (3) bar holes for starters put down; (4) starters used to thaw holes about 8 feet deep; (5) starters pulled and long points placed in starter holes; (6) points driven down through gravel and into bedrock; (7) points allowed to steam in bedrock from 12 to 48 hours, depending on the formation; (8) points pulled, cleaned, and straightened; (9) header moved and starters put down and cycle begun again.

The improvements that have been made in steam thawing since it was adopted for large-scale dredging operations are too many to attempt to detail in a short paper. They have taken the following general lines: (1) Reduction in fuel; (2) increase in efficiency of hose and points; (3) reduction in cost of driving.

The fuel has been reduced by improving the quality, reducing the radiation losses, purifying the feed water, and improving the combustion. Experiments were made both with coal and fuel oil as a substitute for wood. The points have been greatly improved in material and manufacture, and the hose has been improved in quality and its life increased. Metal hose has been used for this work with success. The cost of driving has been reduced by improvement in the method of driving, correct spacing of points, and correct pressure and amount of steam.

The question most often asked in connection with dredging in the North is, What does it cost to thaw and dredge frozen ground? This is a difficult question to answer on account of the wide variation in conditions. All of the creek deposits contain some areas of naturally thawed ground. The percentage of frozen and thawed areas varies on the same stream, and still wider variations occur from one stream to another. This variation reflects itself in the cost per cubic yard, the cost going up or down as the percentage of frozen ground increases or diminishes.

Another variable factor is the cost of thawing or preparing the frozen ground for dredging. Thawing on Hunker Creek, for example, is a much more difficult and expensive operation than thawing on Bonanza. In 1911 the thawing for dredge No. 4 on Hunker Creek cost $2.18 per square yard, as against $1.085 ahead of No. 5 on Bonanza. The depth being practically the same, the cost of thawing per cubic yard was twice as great in the one case as in the other. Purely local conditions govern this cost, such as depth of ground, character of material, ease or difficulty in driving, time of steaming, cost of fuel, etc. Since the gold, practically speaking, is all confined to the bedrock, the cost per square yard of bedrock thawed becomes the controlling factor in determining what ground can be dredged at a profit and what must be left.

The appended tables show the thawing and dredging cost for the last six years of the Yukon Gold Co.'s operation. Table 4 shows the variation in working cost for the different dredges in one season. As the conditions change, the dredge holding the lowest cost for one season may show the highest cost for the next. When the costs for the eight dredges are totaled and averaged the results over several seasons are remarkably uniform.

While Table 1 shows a gradual reduction in the thawing cost, it does not reflect the improvement in efficiency, which has been marked. It is a rare occurrence now for a dredge to strike a piece of ground that is not thoroughly thawed. The improvement in this direction is shown by the gain in duty per dredge-hour, which increased from 162 cubic yards per hour in 1910 to 204 cubic yards per hour last year.

TABLE 1.—*Thawing cost, Yukon Gold Co., 1909–1914.*

Year.	Area worked.				Cost of thawing.	
	Total (square yards).	Frozen (square yards).	Naturally thawed.		Total.	Per square yard.
			Square yards.	Per cent.		
1909	298,061	212,903	85,158	28.6	$275,112	$1.5571
1910	396,837	256,033	140,804	35.5	500,689	1.7727
1911	555,393	432,693	122,700	22.1	696,034	1.6166
1912	692,522	509,574	182,948	26.4	804,854	1.455
1913	651,505	445,624	205,881	31.6	685,570	1.546
1914	586,737	402,660	184,077	31.4	602,174	1.428

TABLE 2.—*Dredging and thawing costs, Yukon Gold Co., 1909–1914.*

Year.	Cubic yards dredged.	Thawing cost per cubic yard.		Total cost per cubic yard (cents).
		Cents.	Percentage of total cost.	
1909	2,381,880	15.45	48.37	31.94
1910	3,249,788	14.14	45.57	31.09
1911	4,151,249	17.62	49.72	35.43
1912	5,157,280	15.02	49.03	30.64
1913	5,133,575	13.57	45.94	29.53
1914	4,800,781	12.18	44.09	27.62

TABLE 3.—*Detail of thawing costs, Yukon Gold Co., 1913.*

	Total expenditures.	Cost per squard yard (cents).	Percentage of total cost.
Fixed salaries	$1,614.00	0.4	0.23
Labor	289,195.38	65.2	42.18
Fuel	295,928.03	66.7	43.17
Shop expense	1,722.16	.4	.25
Preliminary expense	36,021.74	8.1	5.25
Material and supplies	23,180.50	5.2	3.38
Stables	6,589.27	1.5	.96
Transportation	198.00	.1	.03
Miscellaneous	380.33	.1	.06
Depreciation	30,731.37	6.9	4.48
Power	9.45	.....	.01
	685,570.23	154.6	100.00

Square yards thawed, 443,567; number of points driven, 63,004; cost per point driven, $10.88.

TABLE 4.—*Thawing and dredging costs of individual dredges of Yukon Gold Co.*

Dredge No.	Locality.	Percentage of area naturally thawed.	Thawing cost per cubic yard (cents).	Total cost per cubic yard (cents).
1	Bonanza Creek	22.1	12.55	31.93
2	.....do	34.6	12.28	32.55
3	.....do	14.0	18.36	33.79
4	Hunker Creek	7.2	17.95	32.11
5	Bonanza Creek	44.8	12.34	27.01
6	.....do	18.6	16.38	33.36
8	Upper Bonanza Creek	33.7	12.97	27.92
9	Eldorado Creek	58.6	7.49	21.16

Some attempts at gold dredging were made in Alaska as early as 1900. This form of mining did not, however, reach a profitable stage until 1903, when two small dredges were successfully operated in Seward Peninsula. Dredging began in the Fortymile district in 1907 and in the Iditarod, Birch Creek, and Fairbanks districts in 1912. Up to the end of 1915 gold to the value of $12,430,894 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, 1903–1915.

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	170,901			
1909	14	424,993			12,430,894
1910	18	800,000			

TIN.

The Alaska mines produced 102 tons of metallic tin, valued at $78,846, in 1915, compared with 104 tons, valued at $66,560, in 1914. There was some increase in the output from the York district and a very decided falling off in the tin recovered from the gold placer mines of the Hot Springs district. No lode tin was produced in 1915, though developments of tin-bearing lodes continued. The subjoined table shows the tin production of Alaska since mining began in 1902. The figures for the earlier years are not accurate but are based on the best information available. The values given in the table are based on the average price of metallic tin for each year and do not represent the amount actually received for the crude ore by the producer. The average price of metallic tin during 1914 was 35.70 cents a pound; during 1915, 38.66 cents a pound.[1]

Tin produced in Alaska, 1902–1915.

Year.	Quantity (tons of metallic tin).	Value.	Year.	Quantity (tons of metallic tin).	Value.
1902	15	$8,000	1910	10	$8,335
1903	25	14,000	1911	61	52,798
1904	14	8,000	1912	130	96,000
1905	6	4,000	1913	69	44,103
1906	34	38,640	1914	104	66,560
1907	22	16,752	1915 (preliminary estimate)	102	78,846
1908	25	15,180			
1909	11	7,638		628	458,852

[1] Information from Frank L. Hess, of the U. S. Geological Survey.

The York Dredging Co., which is the largest producer, operated its dredge for 87 days on Buck Creek. Its season of operations was somewhat shorter than the normal season, owing to a late spring and early fall. The American Tin Dredging Co. installed a double-flume screen dredge having buckets of 2 cubic feet capacity on upper Buck Creek in 1915. This machine is operated by an 80-horsepower distillate engine and has an estimated daily capacity of 800 cubic yards. The dredge was completed in September and operated for the rest of the open season. The American Gold Dredging Co. operated two dredges on Anikovik River during 1915. One of them is of a double-flume screen type equipped with buckets holding 2 cubic feet; the other is a single-flume dredge with 1¾-foot buckets. The gravels mined by these dredges carry both placer gold and tin. Operations were begun on June 15 and continued until October 15. The four dredges mentioned employed about 50 men. It is reported that some tin-bearing gravels were sluiced on Sutter Creek, which flows into Buck Creek.

Developments were continued at several of the lode-tin properties in the York district during 1915. The noteworthy operations were the continuation of work at the mine of the Jamme syndicate, on Lost River, and on claims of the Bartell's Tin Mining Co. and the United States Tin Mining Co., on the eastern slope of Cape Mountain.

In the Hot Springs district eight operators reported the recovery of small quantities of stream tin incidental to gold placer mining. A churn drill was used extensively during 1915 to prospect for stream tin on Killarney Creek, a tributary of Baker Creek.

LEAD.

Although silver-galena deposits were among the first ores to attract attention in Alaska, practically none of them have been developed on a productive basis. Considerable lead has been produced, however, incidentally to the mining of lodes that were valuable chiefly for their gold content.

In 1915 the Alaska mines produced 437 tons of lead, valued at $41,118, compared with a production in 1914 of 28 tons, valued at $1,344.[1]

[1] Value calculated on the average price of lead during the two years, which according to C. E. Siebenthal, of the U. S. Geological Survey, was 4.7 cents a pound in 1915 and 3.9 cents in 1914.

The following table shows the lead production of Alaska, so far as can be determined from the available data:

Estimate of lead produced in Alaska, 1892–1915.

Year.	Quantity (tons).	Value.	Year.	Quantity (tons).	Value.
1892	30	$2,400	1905	30	$2,620
1893	40	3,040	1906	30	3,420
1894	35	2,310	1907	30	3,180
1895	20	1,320	1908	40	3,360
1896	30	1,800	1909	69	5,934
1897	30	2,160	1910	75	6,600
1898	30	2,240	1911	51	4,590
1899	35	3,150	1912	45	4,050
1900	40	3,440	1913	6	528
1901	40	3,440	1914	28	1,344
1902	30	2,460	1915	437	41,118
1903	30	2,520			
1904	30	2,580		1,261	109,604

ANTIMONY.[1]

There has in the past been considerable prospecting of deposits of antimony (stibnite) in Alaska, notably at the Sliscovich mine, in the Nome district, from which a few test shipments of ore were made as early as 1906. Until 1915, however, there was no commercial production in the Territory. The high price of antimony during the last two years has stimulated the development of stibnite deposits, and in 1915 shipments of stibnite ore were made from six Alaska mines. The records are incomplete as to the total ore produced, but the shipments were 833 short tons, valued at about $74,000. This ore probably averaged 58 per cent of metallic antimony. It is difficult from the information at hand to obtain any exact valuation of the stibnite ore shipped from Alaska. The evidence indicates that the producer received from $1.25 to $1.75 per unit of antimony and that the crude stibnite ore probably sold at an average price of $86 a ton at San Francisco, to which all the shipments were made. From this average has been computed the value of the total output given above.

Of the six antimony mines, four are in the Fairbanks district and two in the Nome district. The producing Fairbanks mines are the Scrafford, in the Treasure Creek basin; the Stibnite, in the Eva Creek basin; the Gilmer, in the Vault Creek basin; and the Chatham Creek mine. All the operations at these mines were on a small scale. The mining consisted chiefly of making open cuts and digging out the ore, which occurs in shoots, kidneys, and irregular masses along zones of fissuring. Most of the ore was broken and hand sorted, and no ore carrying less than 50 per cent of antimony was shipped. The ore was hauled to the railway by wagons and then sent by rail to Fairbanks

[1] Brooks, A. H., Antimony deposits of Alaska: U. S. Geol. Survey Bull. 649 (in press).

and over the all-water route to San Francisco. The transportation companies offered a low freight rate to encourage the new industry. Some work was also done on other stibnite lodes in Fairbanks district.

Developments were continued on the Sliscovich mine, in the Nome district. The ore from this property carries gold, and the mine has been worked for the gold content. In 1915, however, the energies of the operators were directed toward getting out stibnite ore. Some stibnite was also mined at the Hed & Strand property, a few miles north of the Sliscovich mine. Some developments are reported on other stibnite-bearing lodes in the Nome district.

Stibnite is not an uncommon mineral in Alaska, and the recent demand for antimony has led to the prospecting of stibnite deposits in the Kantishna district, on Prince William Sound, on Kenai Peninsula, and in the Yentna district.

MINERAL FUELS.

There were no important developments in the coal or oil fields of Alaska during 1915. Under the new leasing law a number of permits were granted to mine coal in 10-acre tracts or less, and as a result some lignitic coal was mined at a number of localities to supply a local market. The largest of these operations was at the Bluff Point mine, on the north side of Kachemak Bay, an eastern indentation of Cook Inlet. This property was operated for most of the year, and its product was marketed at Seward, Anchorage, and other places near by. Smaller operations were carried on to supply coal to placer mining plants in the Yentna and Fairhaven districts and probably at other localities. It is estimated that the total production was about 1,400 tons, valued at $3,300.

The subjoined table shows the coal consumption of Alaska, including both imports and local production, since 1899. Most of the coal thus far mined is lignite. There was, however, 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 the United States Navy. Most of the foreign coal shipped to Alaska is bituminous, only a little being anthracite. In 1915, 1,771 tons of foreign anthracite was imported into Alaska.

Coal consumed in Alaska, 1899 to 1915, in short tons.

Year.	Imported from States, chiefly from Washington.		Produced in Alaska, chiefly subbituminous and lignite.[a]	Total domestic, chiefly from Washington.[a]	Total foreign coal, chiefly bituminous from British Columbia.[b]	Total coal consumed.
	Bituminous.	Anthracite.				
1899	[c] 10,000	.....	[c] 1,200	11,200	50,120	61,320
1900	15,048	.....	[c] 1,200	16,248	56,623	72,871
1901	[c] 24,000	.....	[c] 1,300	25,300	77,674	102,974
1902	[c] 40,000	.....	2,212	42,212	68,363	110,575
1903	64,625	1	1,447	66,073	60,605	126,678
1904	36,689	.....	1,694	38,383	76,815	115,198
1905	67,707	6	3,774	71,487	72,567	144,054
1906	68,960	533	5,541	75,034	47,590	122,624
1907	45,130	1,116	10,139	56,385	88,596	144,981
1908	23,402	491	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	37,062	.....	.....	37,062	21,882	58,944
1915	41,365	.....	[c] 1,400	42,765	36,878	79,643
	660,926	2,147	40,369	703,442	1,087,741	1,791,183

[a] By calendar years. [b] By fiscal years ending June 30. [c] Estimated.

Of the coal shipped to Alaska in 1915, 4,409 tons [1] went to Nome and represents the total coal consumption of Seward Peninsula, except for a little lignite mined on Chicago Creek. The small consumption is due to the fact that most of the dredges, which are the largest consumers of fuel, use either crude oil or gasoline. About 50 tons of coal is shipped each year to St. Michael, which includes the local consumption and the blacksmith coal for the Yukon camps.

The passage of the coal-leasing act has again attracted attention to the development of the Alaska fields. As a consequence some systematic investigations were made by those who contemplated application for leases, notably in the Matanuska field, which will soon be rendered accessible by the Government railroad now under construction.

The Nenana field (see Pl. I) has also attracted some attention, for on the development of this field rests the future of the Fairbanks gold placers, where cheaper fuel is a prime necessity. As but few analyses of the Nenana coals have been published, the following, which have been furnished through the courtesy of the Director of the Bureau of Mines, are given:

[1] Data received through the courtesy of the deputy collector of customs at Nome.

Analyses of coal from Nenana field, Alaska.

[By Bureau of Mines.]

	Moisture.	Dry coal.				Heating value.					
						As received.		Dry coal.		Moisture and ash free.	
		Volatile matter.	Fixed carbon.	Ash.	Sulphur.	British thermal units.	Calories.	British thermal units.	Calories.	British thermal units.	Calories.
1	28.16	48.05	46.88	5.07	0.21	8,077	4,487	11,243	6,246	11,822	6,580
2	27.41	47.76	46.14	6.10	.22	8,287	4,604	11,416	6,342	12,157	6,754
3	25.73	49.00	46.48	4.52	.20	8,735	4,853	11,761	6,534	12,317	6,843
4	28.52	47.97	46.99	5.04	.08	8,089	4,494	11,317	6,287	11,918	6,621

1. West bank of Nenana River, 1½ miles below Lignite Creek.
2. Healy Creek, 6½ miles from mouth.
3, 4. Igloo Creek, tributary to Healy Creek, 6 miles from mouth.

The sample from Nenana River was collected by Thomas Riggs, jr., of the Alaskan Engineering Commission, and the writer is indebted to him for the following notes on the occurrence. The sample was taken from a 5-foot bed of lignitic coal exposed on the west cut bank of the river about 1½ miles below Lignite Creek. It appears that the coal bed was much thicker but only the upper 5 feet was exposed. The bed dips about 15° NW. and has a roof of cemented gravel and a floor of sandstone. Mr. Riggs states that this particular outcrop would be covered at high water. The sample was sealed in an air-tight can two days after it was collected.

The other three samples were collected in 1913 by the late Dr. Joseph A. Holmes, and unfortunately details regarding localities and methods of sampling are not available. They serve, however, to indicate the composition of the lignitic coals of the Nenana field, the geologic conditions of which have been described by Capps.[1]

Reports on all the accessible Alaska coal fields have been published by the Geological Survey, and the Matanuska and Bering River fields have been surveyed in detail. In view of the present interest in Alaska coal the following reference list, which includes the principal Survey publications relating to this matter has been prepared. The publications marked with an asterisk (*) are out of stock at the Survey office but may be purchased from the Superintendent of Documents, Washington, D. C., at the prices stated. The other publications may be obtained free (except as indicated) on application to the Survey.

Atwood, W. W., Geology and mineral resources of parts of the Alaska Peninsula: Bull. 467, 1911. Describes the Herendeen Bay, Chignik Bay, and Unga Island fields, and is accompanied by topographic and geologic reconnaissance maps.

[1] Capps, S. R., The Bonnifield region, Alaska: U. S. Geol. Survey Bull. 501, 1912.

*Brooks, A. H., The Circle precinct: Bull. 314, 1907. Describes the coal of Washington Creek, on the upper Yukon. Price 30 cents.

——— Alaska coal and its utilization: Bull. 442–J, 1910. Describes briefly the coal fields of Alaska.

*——— The Alaskan mining industry in 1913: Bull. 592, pp. 43–74, 1914. Describes an occurrence of coal near Iditarod. Price 60 cents.

Capps, S. R., The Bonnifield region, Alaska: Bull. 501, 1912. Describes the Nenana coal field and is accompanied by geologic and topographic reconnaissance maps.

*Collier, A. J., The coal resources of the Yukon: Bull. 218, 1903. Describes the coals of the Yukon River and is accompanied by geologic reconnaissance map. Price 15 cents.

*——— Geology and coal resources of the Cape Lisburne region, Alaska: Bull. 278, 1906. Describes the Corwin and Cape Lisburne coal fields. Accompanied by geologic reconnaissance map. Price 15 cents.

*Henshaw, F. F., Mining in the Fairhaven district: Bull. 379, 1909, pp. 355–369. Describes the Chicago Creek coal mine. Price 50 cents.

Maddren, A. G., Mineral deposits of the Yakataga district: Bull. 592–E, 1914. Describes the Yakataga coal field and is accompanied by economic and reconnaissance map.

*Martin, G. C., Geology and mineral resources of the Controller Bay region, Alaska: Bull. 335, 1908. Describes the Bering River coal field and includes detailed geologic, economic, and topographic maps. Price 70 cents.

——— Map of Bering River coal field showing distribution of the various kinds of coal and location of the sections and coal samples described in Bulletin 335. For sale by Geological Survey, price 25 cents.

Martin, G. C., and Katz, F. J., Geology and coal fields of the lower Matanuska Valley, Alaska: Bull. 500, 1912. Describes the coal fields of the lower Matanuska Valley, including the Chickaloon area. Report includes detailed geologic, economic, and topographic maps.

Martin, G. C., and Mertie, J. B., jr., Mineral resources of the upper Matanuska and Nelchina valleys: Bull. 592–H, 1914. Describes the coal fields of the upper Matanuska Valley. Accompanied by a small-scale economic map.

Martin, G. C., Johnson, B. L., and Grant, U. S., Geology and mineral resources of Kenai Peninsula, Alaska: Bull. 587, 1915. Describes the Kachemak Bay coal field of Cook Inlet and is accompanied by geologic and topographic reconnaissance maps.

*Moffit, F. H., The Fairhaven gold placers, Seward Peninsula, Alaska: Bull 247, 1905. Describes the occurrence of coal at Chicago Creek. Accompanied by geologic and topographic reconnaissance maps. Price 40 cents.

*Schrader, F. C., A reconnaissance in northern Alaska across the Rocky Mountains, along Koyukuk, John, Anaktuvuk, and Colville rivers, and the Arctic coast to Cape Lisburne, in 1901, with notes by W. J. Peters: Prof. Paper 20, 1904. Describes the occurrence of coal in the Colville Valley. Accompanied by geologic and topographic reconnaissance maps. Price 40 cents.

Smith, P. S., The Noatak-Kobuk region, Alaska: Bull. 536, 1913. Describes the occurrence of coal in the Kobuk Valley. Accompanied by geologic and topographic reconnaissance maps.

Smith, P. S., and Eakin, H. M., A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska: Bull. 449, 1911. Describes the coal deposits of Norton Bay region and is accompanied by geologic and topographic reconnaissance maps. Price 40 cents.

*Spencer, A. C., The Juneau gold belt; Wright, C. W., A reconnaissance of Admiralty Island: Bull. 287, 1906. Describes the Kootznahoo Inlet coal field on Admiralty Island. Accompanied by geologic reconnaissance map. Price 75 cents.

The form of the lease and regulations governing the same have recently been made public by the Secretary of the Interior.[1] In view of the widespread interest on the part of the Alaska mining public in the development of the coal, the following data are presented, stating the conditions under which leases are granted.[2]

COAL-MINING LEASE.

Date.

THIS INDENTURE OF LEASE, entered into, in quintuplicate, this ..... day of ....., A. D., 19.., by and between the United States of America, acting in this behalf by .....

Parties.

....., Secretary of the Interior, party of the first part, hereinafter called the lessor, and .....

.....

party of the second part, hereinafter called the lessee, under and pursuant to the act of Congress, approved October 20, 1914 (38 Stat., 741), entitled "An act to provide for the leasing of coal lands in the Territory of Alaska, and for other purposes," hereinafter called the "coal leasing act,"

WITNESSETH.

That the lessor, in consideration of the rents and royalties to be paid and the covenants to be observed as hereinafter set forth, does hereby grant and lease to the lessee, for the period of fifty years from the date

Purposes.

hereof, the exclusive right and privilege to mine and dispose of all the coal and associated minerals in, upon or under the following described tracts of land, situated in the Territory of Alaska, to wit: .....

Description of land.

.....

containing ..... acres, more or less, together with

Mining and surface rights.

the right to construct coke ovens, briquetting plants, by-products plants, and all such other works as may be necessary and convenient for the mining and preparation of coal and associated minerals for market, the manufacture of coke or other products of coal, and to use so much of the surface and the sand, stone, timber and water thereon as may reasonably be required in the exercise of the rights and privileges herein granted, the use of such timber to be subject to such regulations as may be prescribed by the Secretary of the Interior under the act approved May 14, 1898 (30 Stat., 414), and the acts amendatory thereof.

[1] Lane, F. K., Regulations governing coal-land leases in Territory of Alaska, Washington, Interior Dept., 1916.
[2] Idem, pp. 14–32.

ARTICLE I.

SECTION 1. The lessor expressly reserves unto itself the right to grant or use such easements in, over, through or upon the land leased, entered, located, occupied, or used as may be necessary or appropriate to the working of the same or other coal lands by or under authority of the Government and for other purposes; also the right to use, lease, or dispose of so much of the surface of the said lands as may not be actually needed, or occupied by the lessee in the conduct of mining operations. Rights reserved by lessor.

ARTICLE II.

It is expressly understood and agreed, that this lease is granted subject in all respects to the conditions, limitations, penalties and provisions contained in the "Coal Leasing Act," which act is hereby made a part hereof to the same extent as if incorporated herein. Lease subject to "Coal Leasing Act."

ARTICLE III.

It is further expressly understood and agreed that the mining rights and privileges leased as aforesaid shall extend to and include only coal and associated minerals, as hereinafter defined, and that no rights or privileges respecting any other kind or character of mineral, or mineral substance whatsoever, are granted or intended to be granted by this lease. Mining rights limited to coal and associated minerals.

ARTICLE IV.

The lessee in consideration of the lease of the rights and privileges aforesaid hereby covenants and agrees as follows:

SECTION 1. To invest in actual mining operations upon the leasing block included herein, the sum of ..... Investment.

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dollars, of which sum not less than one-fifth shall be so expended during the first year succeeding the execution of this instrument, and a like sum each succeeding year for the period of four years; to furnish a bond, within 10 days after signature of the lease, in the sum of one-half the amount to be expended each year, conditioned upon the expenditure of such sum within said period, and submit annually, at the expiration of each year for the said period, an itemized statement, as to the amount and character of the expenditure during said year.

SEC. 2. To pay as an annual rental for each acre or part thereof covered by this lease, the sum of 25 cents per acre for the first year, payment of which amount is hereby acknowledged, the sum of 50 cents per acre per year for the second, third, fourth, and fifth years, and $1 per acre for the sixth and each succeeding year during Annual rental.

the life of this lease, all such annual payments of rental to be made on the anniversary of the date hereof, and to be credited on the first royalties to become due hereunder during the year for which said rental was paid.

Royalty.

SEC. 3. To pay a royalty of 2 cents on every ton of 2,000 pounds of coal shipped or removed from the leased lands or manufactured into coke, briquets or other products of coal, or consumed on the premises, during the first five years succeeding the execution of this lease, and 5 cents per ton for the next 20 years. Royalties shall be payable at the end of each calendar month next succeeding that of the said shipment, removal, donation, manufacture or consumption.

Lessee to keep record of all coal shipped.

SEC. 4. To accurately weigh all coal shipped or removed from the leased premises, sold, or donated to local trade, manufactured into coke, briquets, or other products of coal, or otherwise consumed or utilized, and to accurately enter the weight or weights thereof in due form in books to be kept and preserved by the lessee for such purpose, together with the car numbers, if any, of the coal shipped by rail.

Reports to be furnished monthly by lessee.

SEC. 5. To furnish in manner and form and at such time during each calendar month as the lessor shall prescribe, but in no event later than the last day thereof, the following written reports covering the month immediately preceding, certified under oath by the superintendent at the mine, or by such other agent on the property having personal knowledge of the facts as may be designated by the lessee for such purpose, to wit:

A report copied from the books required to be kept at the mine under section 4 of this article showing the facts required to be entered therein; a report of the number of mine cars of mine-run coal hoisted or trammed from each coal bed of each separate mine; a report showing the quantity, size, and character of coal shipped, used for power purposes and lease consumption; donated to employees, manufactured into coke, briquets, or other products or by-products of coal; in storage on the premises, with the quantity of coal of various sizes added thereto and taken therefrom during the month.

ARTICLE V.

Periods for readjustment of royalty.

It is mutually understood and agreed that the lessor shall have the right to readjust and fix the royalties payable hereunder at the end of 25 years from the date hereof, and at the end of 15 years thereafter, and thereafter at the end of each succeeding 10-year period during the continuance of this lease: *Provided*, That in any such readjustment the royalty fixed shall not exceed 5 per cent of the average selling price of coal of like character at the mine, per ton of 2,000 pounds in the coal field embracing the tracts covered by this lease, as shown by the books of the lessees operating in said field during a period of five years next preceding such readjustment.

ARTICLE VI.

This lease is made subject to the following provisions, which the lessee accepts and covenants faithfully to perform and observe:

Mining operations to be energetically prosecuted.

SECTION 1. The lessee shall diligently proceed to prospect for, develop, and mine the coal in or upon the leased lands; shall carry on all mining operations in a good and workmanlike manner, having due regard to the health and safety of miners and other employees; and shall leave no available coal abandoned which could be recovered by the most approved methods of mining when in the regular course of mining operations the time shall arrive for mining such coal. No mine, entry, level, or group of rooms or workings shall be permanently abandoned and rendered inaccessible, save with the approval of the authorized representative of the lessor.

Workings not to be abandoned until examination made.

Preliminary plan of mining to be submitted in advance of operations on a commercial scale.

SEC. 2. And also shall develop and mine the coal in the leased lands in accordance with a system to be shown by a preliminary plan on a scale of not more than 200 feet to the inch and a written description thereof, which plan and description shall be submitted for approval by the authorized representative of the lessor.

Where two or more beds of coal pillars in lower beds to be left until coal in upper beds extracted. Exceptions.

SEC. 3. And also where more than one bed of coal is known to exist in the leased lands, shall not draw or remove the pillars in any lower bed, before the available coal in any or all upper beds has been mined, unless it shall be decided by the authorized representative of the lessor that the workings in any or all of the upper beds will not be seriously injured by the extraction of the pillar coal in the lower workings. Where mining operations are being carried on in a bed that lies either below or above another bed in which mining has been or is being carried on and in which the pillars have not been pulled, and where the vertical distance between the two beds is less than fifteen times the thickness of the lower of the two beds, the lessee shall, as far as practicable, so arrange the pillars that those in the lower bed shall be vertically beneath those in the upper bed. Where practicable, by reason of either commercial or mining conditions, the available coal in the upper beds shall be exhausted before the coal in the lower beds is mined.

Pillars in lower beds to be arranged vertically under pillars in upper beds.

Fifty-foot barrier pillars.

SEC. 4. And also shall not, without the consent in writing of the authorized representative of the lessor first had and obtained, mine any coal, or drive any underground working, or drill any lateral bore hole within 50 feet of any of the outside boundary lines of the leased lands, nor within such greater distance of such boundary lines, as the said representative shall prescribe for the protection of the property or the safeguarding of mining operations hereunder; but in the event the coal up to the like barrier in adjoining premises shall have been worked out and exhausted, and the water therein shall have been lowered below the working level of the opera-

Lessee may be required to mine barrier pillars on adjacent lands.

tions on the same bed on the lands covered by the lease, the lessee hereunder hereby agrees, upon the written demand of said representative, to mine out and remove all the available coal in such barriers, both in the lands covered by this lease and on the adjoining premises, whenever same can be mined without hardship to the lessee and where the coal-mining rights in such adjoining premises are owned by the lessor.

Limitations of coal to be recovered in advance workings under "room-and-pillar" system.

SEC. 5. And also where the "room-and-pillar," or any other system of mining is followed which requires advance workings in the solid coal, including entries, breakthroughs, and rooms, instead of a system of mining under which all the coal is mined out and extracted as the work advances, shall not, without the consent in writing of the lessor being first had and obtained, mine and remove from such advance workings more than the following maximum percentages of the coal area for the specified depths of cover, viz:

Not more than 70 per cent where the cover is 100 feet or over but less than 200 feet in depth; not more than 65 per cent where the cover is 200 feet or over but less than 300 feet in depth; not more than 60 per cent where the cover is 300 feet or over but less than 400 feet in depth; not more than 55 per cent where the cover is 400 feet or over but less than 500 feet in depth; not more than 50 per cent where the cover is 500 feet or over but less than 750 feet in depth; not more than 45 per cent where the cover is 750 feet or over but less than 1,000 feet in depth; not more than 40 per cent where the cover is 1,000 feet or over but less than 1,250 feet in depth; not more than 35 per cent where the cover is 1,250 feet or over but less than 1,500 feet in depth; not more than 30 per cent where the cover is 1,500 feet or over but less than 1,750 feet in depth; not more than 25 per cent where the cover is 1,750 feet or over but less than 2,000 feet in depth; not more than 20 per cent where the cover is 2,000 feet or over.

Definition of term "percentage of area."

The said coal areas shall mean an area parallel with the dip or raise of the coal bed. The percentages of coal areas specified shall mean the percentages of coal to be mined in the areas comprised in the advance workings as compared with the percentages of coal to be left standing in such workings, and shall not be construed to mean the percentage of the total amount of coal in any such area of any such bed, where such bed in such area is thicker than the height of any such workings, nor shall such percentages of areas be held to include the coal extracted from the pillars in any such area, panel, or district of the mine, as it is the intent of the parties hereto that save as otherwise provided in this lease, and except where the retention of pillars shall be necessary for the maintenance of main roads or passageways or for the protection of the property, all such pillars shall be mined and removed as rapidly as proper mining will permit.

Pillars to be removed as rapidly as possible.

Exceptions.

Fires in mine prohibited.

SEC. 6. And also shall not, save as hereinafter authorized, light, keep, or maintain any fire in any mine or stripping, except as approved by the authorized representative of the lessor, or underground in any mine, or in contact with the coal in place or in or along the outcrop of any coal bed. Failure to take prompt and vigorous steps for the extinguishment of any such fire shall be sufficient ground for the entry of the lessor and the cancellation of this lease.

Discovery of valuable mineral substance other than coal to be reported.

Lessee to have free use of fire clay and natural gas for lease purposes.

Record of associated minerals mined to be kept.

SEC. 7. And also shall promptly notify the authorized representative of the lessor of the discovery of any valuable mineral or mineral substance other than coal in the course of mining operations hereunder, and shall not mine or remove same unless the same is an associated mineral as hereinafter defined: *Provided*, That such quantities of fire clay, shale, or gas from the coal measures as may be required by the lessee in the conduct of operations hereunder may be removed and used without such written permission and without payment of royalty therefor. The lessee shall keep careful and accurate record in manner and form as may be prescribed by the lessor of all such associated minerals mined, used, or carried away, and shall pay such rates of royalty thereon as may be fixed by the said lessor, except as above provided.

Mine map required to be kept at the mine office.

SEC. 8. And also shall keep at the mine office clear, accurate, and detailed maps on a scale of 100 feet to the inch, in the form of a horizontal projection on tracing cloth, of the workings in each coal bed in each separate mine on the leased lands, a separate map to be made for each such bed, and for the surface immediately over the underground workings, and to be so arranged with reference to a public land corner that the maps can be readily superimposed.

Things required to be shown on detailed map of workings.

Each map of the workings in any coal bed shall show the location of all openings connecting such bed with the workings in any other bed, or with any adjacent mine, or with the surface; the location of all entries, gangways, rooms, or breasts, and any other narrow or wide workings, including the outlines of abandoned workings, and record of whether accessible or inaccessible; also barrier pillars, refuge chambers, stoppings, ventilating doors, overcasts, undercasts, regulators, and direction of air currents at the time of making map; location of stationary haulage and hoisting engines; permanent electrical generators, dynamos, and transformers; indications of trolley roads throughout their extent; also fire walls, sumps, and large bodies of standing water; position of main pumps and fire pipe lines; there shall also be marked on such maps the elevations above or below sea level or approved datum at points not over 200 feet apart horizontally, or over 100 feet apart vertically, in all main slopes, entries, levels, or headings, together with the thickness of coal beds at such intervals, and the elevations at the tops and bottoms of all shafts, slopes, and inclines.

Requirements for map of surface over working.

The map of the surface immediately over the mine workings shall show all prominent topographic features and culture, section and township lines, the elevations above sea level or an approved datum, and contours at vertical intervals of 25 feet of such topographic features. Such map, together with the maps of the underground workings, shall be brought up to date not less than once in every six months.

Things required to be shown on general property map to be kept at mine office.

The lessee shall also make and keep at the mine office, at such time after the commencement of mining operations as the authorized representative of the lessor may direct, a clear and accurate general map of the entire leased lands, on a scale of 400 feet to the inch. Such map shall show all prominent topographical features and culture; the location of the surface areas immediately over the mine workings shown on the detailed surface map hereinbefore required; township, section, and property lines; the location of high-water marks; the outline of coal outcrops where known; the outlines of the chief mine workings, indicating the workings in each separate coal bed by distinguishing marks and the elevations above sea level or an approved datum, and contours at vertical intervals of 25 feet of the chief topographic features. Such map shall be brought up to date not less than once in every six months.

Prints of maps to be furnished lessor.

Blue prints or reproductions in duplicate of the maps required as aforesaid shall be furnished the authorized representative of the lessor when made, and supplemental prints or reproductions in duplicate furnished on or before January 1 of each succeeding year, showing the extensions, additions, and changes since the last map or supplement was submitted. All mine progress maps kept by the lessee shall at all times be subject to examination by said representative.

Abandoned areas to be surveyed and mapped.

The lessee whenever any mine, or any workings therein are to be abandoned or indefinitely closed, and before same shall be abandoned or closed, or allowed to become inaccessible, shall make a survey thereof so as to accurately show the entire worked-out area or areas, and shall extend the results of such survey on the map or maps of the underground workings hereinbefore required, and promptly forward blue prints or reproductions thereof in duplicate to the said representative.

Maps may be made at lessee's expense in case of failure to furnish.

If the lessee shall fail to make or furnish any map or extension or revision as herein required within 90 days after demand therefor shall have been made by the authorized representative of the lessor, such representative may employ a competent engineer to make a survey of the mine, and plat the same as above provided, the expense thereof to be paid by the lessee, and in the event that the lessee shall fail to make such payment within 60 days after demand therefor by the authorized representative of the lessor, such failure shall constitute a cause of forfeiture of this lease.

Second exit to surface to be provided, where more than 10 men employed on a shift.

SEC. 9. And also shall, where more than ten men are employed underground on any one shift in any separate mine, provide an escapeway or second exit to the surface, which shall be separated at the surface from the first exit by not less than 50 feet of strata in case of drift, slope, or tunnel workings, or in case of vertical shafts, or of inclined shafts having a pitch of more than 45°, by not less than 200 feet of strata. An escapeway or outlet through an adjoining mine shall be regarded as a satisfactory compliance with this requirement if kept at all time in proper condition for use. If such adjoining mine shall be abandoned at any time, or shall cease to operate indefinitely, the lessee hereunder shall be solely responsible for the cost and expense of maintaining such outlet, and in the event such outlet shall be abandoned or permitted to become unsafe for use, the number of men employed on any one shift shall be reduced below ten until such time as a second exit or escapeway shall be provided.

Outlet through adjacent mine sufficient compliance.

Not more than five men to be employed in new workings unless second opening provided.

Exceptions.

SEC. 10. And also shall not employ more than five men underground on any one shift in any new working of any mine unless such new working shall be so connected with adjacent workings as to provide two distinct and separate means of escape from such new working: *Provided,* That with the approval of the authorized representative of the lessor, not exceeding ten men may be so employed in advance of the making of such second opening, but in no case shall any rooms, drifts, or slopes be opened or worked until such second opening is constructed.

No building of inflammable material to be constructed within 75 feet of any mine.

SEC. 11. And also shall not construct or maintain any structure of inflammable material within 75 feet of any mine opening; nor within said distance permit any structure of noninflammable material to be connected to any other structure by means of any structure or erection of inflammable material, or to be connected to any structure beyond said distance which shall be constructed of inflammable material, except as follows, that is to say:

Exceptions.

(*a*) An open timber framework or headframe of timber may be constructed over a shaft, slope, or incline.

(*b*) The posts, studs, and rafters of any such structure may be of wood if the covering or lining is made of noninflammable material, but under no circumstances shall wood flooring be used, except in tipple and trestle structures.

Main intake and return airways to be separated by not less than 50 feet of natural strata.

SEC. 12. And also, except in a prospect opening, shall separate the main intake and return airways and all workings parallel to such airways by not less than 50 feet of strata except for break-throughs or crosscuts for ventilation or haulage, and shall provide for such greater distance between such airways or between any such airway and parallel workings as may be required in the judgment of the authorized representative of the

Pillars to be left standing until prior to final abandonment of mine.

lessor. The lessee agrees that the pillars thus provided for shall be left standing until in the proper course of mining operations the time shall arrive for their removal immediately prior to the final abandonment of the workings in that particular coal bed.

Ventilating fan to be provided where more than 10 men employed on shift.

SEC. 13. And also shall whenever more than ten men are employed underground on any one shift provide a fan or other mechanical means for circulating such amount of ventilating current as may be required by any law of the United States or of the Territory of Alaska now or hereafter enacted, or by the rules and regulations prescribed by the lessor, such fan or other mechanical means and the connection between same and the point of the entrance of the air current into the mine to be made of noncombustible material; and the lessee shall not set same in line with the axis of any mine opening, but shall place same at a distance of not less than 15 feet from the projection of the nearest side of such opening, and shall provide explosion doors of the full area of the air shaft or airway, in direct line with any and all such mine openings in order to protect said fan or other mechanical means of air circulation in case of a mine explosion: *Provided*, That during such time as the mine is being opened up and less than ten men are employed under ground on any one shift, and with the written approval of the authorized representative of the lessor, a furnace may be used for ventilation in a nongaseous mine if the fire box thereof is inclosed by brick, rock, or concrete walls, and a passageway around such inclosure at least two feet in width provided: *And provided further*, That if a wooden stack is used in connection with such furnace the lessee shall not permit such stack to be in contact with any coal bed or with any inflammable shale.

Fan not to be placed in direct line with any mine entrance.

With written approval of lessor's representative furnace may be used for ventilation under specified conditions.

Slack and refuse to be disposed of so as not to become a public or private nuisance.

SEC. 14. And also shall make such provisions for the disposal of the waste, slack, and refuse of the mine that the same shall not be a nuisance, inconvenience, or obstruction to any right of way, stream, or other means of transportation or travel, or to any private or public lands, or embarrass the operation of any other mine on the leased lands, or on adjoining lands, or in any manner occasion private or public damage, nuisance, or inconvenience. All waste containing practically no coal shall be deposited separate and apart from waste containing coal and in accordance with the directions of the authorized representative of the lessor.

Abandoned workings to be covered or fenced.

SEC. 15. And also shall upon abandonment substantially fence, fill in, cover, or close all surface openings or workings where persons or animals are likely to be injured by falling therein, or endangered by accumulations of gas, except as the lessor shall otherwise direct; and shall maintain all such fencing or covering in a secure condition during the term hereof.

Operations subject to inspection of lessor's representatives.

SEC. 16. And also expressly agrees that all mining and related operations shall be subject to the inspection of authorized representatives of the lessor, and that such representatives, with all proper and necessary assistants, may at all reasonable times enter into and upon the leased lands and survey and examine same and all surface and underground improvements, works, machinery, equipment, and operations, and further expressly agrees to furnish said representatives and assistants all necessary assistance, conveniences, and facilities in making any such survey and examination.

Lessee to furnish all necessary assistance.

Lessee to permit examination of books for purpose of checking royalty returns.

SEC. 17. And also shall permit any authorized representative of the lessor to examine all books and records pertaining to operations under this lease, and to make copies of and extracts from any or all of same, if desired. The information so derived to be held confidential.

Lands leased and easements therein may be used for purposes of rendering operations on adjoining lands more safe; such use to be compensated for.

SEC. 18. And also shall permit the lessor, its lessees, or transferees to make and use upon or under the leased lands any workings necessary for freeing any other mine from water, causing as little damage or interference as possible to or with the mine or mining operations of the lessee hereunder. Any such use by a lessee or transferee shall be conditioned upon the payment to the lessee hereunder of the amount of actual damages sustained thereby and adequate compensation for such use.

Lessee to keep true and accurate weights or measurements of coal mined and loaded by miners.

SEC. 19. And also shall accurately weigh or measure in the car and truly account for the coal mined and loaded by each miner, where the miners are paid either by the weight of their output or upon the basis of the measurement of the coal in the car; keep a correct record of all coal so weighed or measured; post or display such record daily for the inspection of the miners and other interested persons; and require the weighman or person appointed to measure the coal in the car where the miners are paid upon the basis thereof, before entering upon his duties, to make and subscribe to an oath before some person duly authorized to administer oaths that he will accurately weigh or measure and keep true record of the coal so weighed or measured and credit same to the miner entitled thereto, such affidavit to be kept conspicuously posted at the place of weighing, if any, but nothing contained herein shall be construed to prevent the lessee, in case rock and bone is loaded by the miner, from estimating or separately weighing, and deducting the amount thereof from the weights of coal accredited to such miner. The lessee hereby agrees that if a majority of the miners employed on the leased lands so desire they shall be permitted to employ at their own expense one of their fellow employees to see that the coal is properly weighed or measured and that a correct account of same is kept, and agrees to afford such person every facility to certify the weights and measurements while the weighing or measuring is being done: *Pro-*

Weighman to take oath for faithful discharge of duties

Miners to be permitted to employ checkweighman.

Checkweighman to take oath for faithful discharge of his duties.

vided, That the lessee shall not be required to so do unless such person, before entering upon his duties, shall make and subscribe to an oath before some person authorized to administer oaths that he will faithfully discharge the duties of his position, such oath to be kept conspicuously posted at the place of weighing, if any.

Wages to be paid in lawful money.

SEC. 20. And also shall pay all miners and other employees, both above and below ground, at least twice each month in lawful money of the United States, and shall permit such miners and other employees full and

Freedom of purchase to be allowed.

complete freedom of purchase, but with a view to increasing safety this provision shall not apply to the purchase of explosives, detonators or fuses, and shall not require or permit miners or other employees, except in case of emergency, to work underground for more than

Eight-hour work day required.

eight consecutive hours in any one calendar day, not including time for lunch or meals, or the time required to reach the usual working place.

Premises to be surrendered in proper condition for continuance of mining operations.

SEC. 21. And also shall, at the expiration or earlier termination of this lease, deliver up to the lessor the lands covered by this lease, together with all fixtures, improvements, and appurtenances, save as hereinafter provided, in such a secure and proper state that mining operations may be continued immediately to the full extent and capacity of such mine.

ARTICLE VII.

It is further mutually understood and agreed as follows:

Suspension of operations for more than three months without consent to be cause of forfeiture.

SECTION 1. That the suspension of mining operations by the lessee for a longer period than three months without the consent in writing of the lessor or its authorized representatives shall be cause of forfeiture of this lease. If the lessee shall be unable to continue the operation of the mine for any cause, not due to the fault or negligence

Upon application consent for suspension for a specified period may be obtained.

of the lessee, he shall be entitled to the suspension of operations for such a length of time, and upon payment of such minimum royalties, and such other conditions as may be specified in the order of suspension, but the issuance of any such order shall not excuse the payment of any rents or royalties due under this lease, or prevent forfeiture for failure to pay same, and the acceptance of any such rent or royalty shall not waive any other right of the lessor hereunder.

Lease not to be assigned without consent of lessor.

SEC. 2. That the lessee shall not assign this lease or any interest therein, nor sublet any portion of the leased premises, or any of the rights and privileges herein granted, without the written consent of the lessor being first had and obtained.

Breach of lease covenants may be waived in writing.

SEC. 3. That the lessor or its authorized representative may by notice in writing waive any breach of the covenants and conditions contained herein, except such as are required by the aforesaid "coal leasing act," but any such waiver shall extend only to the particular

breach so waived, and shall not limit the rights of the lessor with respect to any future breach. No waiver not in writing shall be in any way binding upon the lessor.

Lease may be terminated at any time upon payment of rents, etc.

SEC. 4. That the lessee may terminate this lease at any time upon giving four months' notice in writing to the lessor or its authorized representative, and upon payment of all rents, royalties, and other debts due and payable to the lessor, and upon payment of all wages or moneys due and payable to the workmen employed by the lessee, but in no case shall such termination be effective until the lessee shall have made provision for the preservation of any mine on the leased lands in accordance with the provisions of this lease: *Provided*, That in such case the right of valuation and purchase, accorded the lessor in the section next following (5), shall be exercised within said period of four months.

Termination not to be effective until property examined.

Lessor to have privilege of valuing and purchasing equipment, etc., on termination of lease.

SEC. 5. That at the expiration or earlier termination of this lease all tools, machinery, and equipment, including tracks, rails, and pipe placed by the lessee in the mine or on the property, shall before removal from normal position, if requested by the lessor or its authorized representatives, be valued by three disinterested and competent persons to be chosen in the manner hereinafter provided for the appointment of arbitrators, the valuation of these three or of a majority of them to be conclusive of the value of any or all of the said property; and the lessor or its agent, licensee, or lessee shall have the right to purchase within four months thereafter any or all such tools, machinery, equipment, or materials at the said valuation, deducting therefrom all rents, royalties, or other payments at that time due and payable by the lessee. If such valuation shall not be requested or the purchase shall not be made within said time the lessee shall have the privilege of removing same from the premises within one year from the expiration or termination of this lease, provided all debts and moneys specified in section 4 of this article shall have been paid. The lessee shall not, and hereby covenants not to, remove any mine supports, timbers, or props in place. All buildings and improvements erected upon the leased lands shall become a part of the property, and machinery and equipment shall not be removed therefrom in such a way as to cause any permanent injury to such buildings or improvements.

Lessee may remove same within year.

Forfeiture of lease.

SEC. 6. That if the lessee shall make default in the performance or observance of any of the terms, covenants, and stipulations of this lease, and such default shall continue for 60 days after service of written notice thereof by the lessor or its authorized representatives, then all the rights and privileges of the lessee cease and determine, and the lessor may, by appropriate proceedings, have this lease forfeited and canceled in a court of competent jurisdiction.

A waiver of any particular cause of forfeiture shall not prevent the cancellation and forfeiture of this lease for

any other cause of forfeiture or for the same cause occurring at any other time.

Questions which may be submitted to arbitration.

SEC. 7. That in case any dispute shall arise between the lessor and lessee as to any question of fact, or as to the reasonableness of any requirement made by the lessor under the provisions of this lease, in the matter of operation, methods, means, expenditures, use of easements, compensation for joint occupancy by another lessee of a portion of the leased premises, or such other questions as are not determined by express statutory provision, such questions or disputes shall be settled by arbitration in the manner provided for by this section, and the lessor and lessee hereby covenant and agree each with the other to promptly comply with and carry out the decision or award of each and every board of arbitration appointed under this section.

Manner of appointing arbitrators.

Questions in dispute to be determined by arbitration hereunder shall be referred to a board of arbitration consisting of three competent persons, one of which persons shall be selected by the lessor or its authorized representative, and one by the lessee, and the third by the two thus selected: *Provided*, That the lessor and lessee may agree upon one sole arbitrator or upon the third arbitrator. The party desiring such arbitration shall give written notice of the same to the other party, stating therein definitely the point or points in dispute, and name the person selected by such party hereto within 20 days after receiving such notice to name an arbitrator; and in the event it does not do so, the party serving such notice may select the second arbitrator and the two thus named shall select the third arbitrator. The arbitrators thus chosen shall give to each of the parties hereto written notice of the time and place of hearing, which hearing shall not be more than 30 days thereafter, and at the time and place appointed shall proceed with the hearing unless for some good cause, of which the arbitrators or a majority of them shall be the judge, it shall be postponed until some later day or date within a reasonable time. Both parties hereto shall have full opportunity to be heard on any question thus submitted, and the written determination of the board of arbitration thus constituted or of any two members thereof or, in case of the failure of any two members to agree, then the determination of the third arbitrator shall be final and conclusive upon the parties in reference to the questions thus submitted. All such determinations shall be in writing, and a copy thereof shall be delivered to each of such parties.

Decision of third arbitrator to be final.

New board to be chosen in event of failure of arbitrators first selected to choose a third.

It is further agreed that in the event of the failure of the lessor and lessee, or of the two arbitrators selected as aforesaid by the parties hereto, within 20 days from notice to them of their selection, to agree upon the third

arbitrator, then the Secretary of the Interior shall appoint such arbitrator.

The said third arbitrator shall receive not to exceed $15 per day as full compensation for his services and for all expenses connected therewith, exclusive of transportation charges; but such compensation shall not be in excess of $150 for any arbitration. The losing party to such arbitration shall be liable for the payment of such compensation and transportation expenses of such third arbitrator.

SEC. 8. That any notice in writing as to any matter mentioned in this lease, addressed to the lessee and left upon the premises with the superintendent, manager, clerk, or other person in charge of the mine or of the office, or, in the absence of any such person, posted on the door of the office, shall have the same force and effect as if served upon the lessee, and 15 days shall be considered a reasonable notice, unless a longer notice be herein provided for or be so provided in such notice.

ARTICLE VIII.

It is further expressly agreed and declared that the terms and phrases hereinafter mentioned shall have the meanings hereinafter assigned unless the context shall otherwise require, that is to say:

(*a*) The phrase "available coal" as used in this lease shall mean merchantable coal from any coal bed which, when reached in the prosecution of the lessee's operations hereunder, can be mined at a reasonable profit by the use of machinery and methods which at that time are modern and efficient.

(*b*) The term "mine" as used herein shall mean and include all underground workings now or hereafter opened or worked for the purpose of mining and removing coal and associated minerals, together with all buildings, machinery, and equipment, above and below ground, used in connection with such mining operations.

(*c*) The term "pit" or "open pit" shall mean and include stripping operations or any open-air workings.

(*d*) The term "coal" as used herein shall mean and include anthracite, semianthracite, semibituminous, bituminous, subbituminous, lignite, and graphitic coal, lignite, natural coke, and such bony coal as is suitable for use as a fuel.

(*e*) The term "associated minerals" as used herein shall mean and include fire clay, shale, sandstone, and the bedded materials of the coal measures, exclusive of gold-bearing or other metalliferous deposits.

(*f*) The term "lessee" as used herein shall mean and include the heirs, executors, administrators, successors, or assigns of the lessee hereinbefore specified.

ARTICLE IX.

It is further mutually covenanted and agreed that each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall insure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

ARTICLE X.

It is also further agreed that no member of or delegate to Congress or resident commissioner, after his election or appointment, or either before or after he has qualified, and during his continuance in office, and that no officer, agent, or employee of the Department of the Interior, shall be admitted to any share or part in this lease, or derive any benefit that may arise therefrom, and the provisions of section 3741 of the Revised Statutes of the United States and sections 114, 115, 116 of the Codification of the Penal Laws of the United States approved March 4, 1909 (35 Stat., 1109) relating to contracts enter into and form a part of this lease so far as the same may be applicable.

In witness whereof—

THE UNITED STATES OF AMERICA,

By ----------[L. S.]

Secretary of the Interior.

Witnesses:

----------[L. S.]

APPLICATION FOR COAL-MINING LEASE.

The undersigned, ----------,

a resident of ----------,

a ----------,

(Native born or naturalized; if the latter, furnish certificate.)

citizen of the United States, over 21 years of age, hereby applies, under the provisions of the act of October 20, 1914 (38 Stat., 741), for a mining lease of the certain leasing blocks, or tracts, of coal lands, to wit: Block ____, embracing the following specified legal subdivisions ----------

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aggregating ____ acres. If I secure said lease, I propose to invest not less than ---------- dollars in active, productive mining operations conducted upon said lease; the active development will begin not later than ---------- My experience in coal-mining operations is as follows: ----------

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I neither own nor hold any interest, either as a stockholder or other-

wise, in any lease under this act, or in any application for such a lease, save and except the application now made; and I hereby refer to ----------
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as to my financial standing.

If I am awarded a lease, I will supply a satisfactory bond as required in section 9 of the regulations.

My post-office address is ----------

(Signed) ----------

Subscribed and sworn to before me, a ----------, ----------, on this ---------- day of ----------

[SEAL.] ----------

COAL-MINING PERMIT.

REGULATIONS GOVERNING THE ISSUANCE OF PERMITS FOR THE FREE USE OF COAL IN THE UNRESERVED PUBLIC LANDS IN ALASKA.

Section 10 of the act of October 20, 1914 (Public 216), provides:

That in order to provide for the supply of strictly local and domestic needs for fuel the Secretary of the Interior may, under such rules and regulations as he may prescribe in advance, issue to any applicant qualified under section three of this act a limited license or permit granting the right to prospect for, mine, and dispose of coal belonging to the United States on specified tracts not to exceed ten acres to any one person or association of persons in any one coal field for a period not exceeding ten years, on such conditions not inconsistent with this act as in his opinion will safeguard the public interest without payment of royalty for the coal mined or for the land occupied: *Provided,* That the acquisition of holding of a lease under the preceding sections of this act shall be no bar to the acquisition, holding, or operating under the limited license in this section permitted. And the holding of such license shall be no bar to the acquisition or holding of such a lease or interest therein.

Owing to there being no settlements or local industries in or adjacent to the Bering or Matanuska coal fields, and the contemplated leasing offer of coal lands in said fields, these regulations and the permits provided for shall not at present apply to coal deposits in those fields.

Qualifications.—Under the terms of the act, expressed in section 3 thereof, only citizens of the United States above the age of 21 years, associations of such citizens, corporations, and municipalities organized under the laws of the United States or of any State or Territory thereof, provided the majority of the stock of such corporations shall at all times be owned and held by citizens of the United States, are eligible to receive a permit to prospect for and mine coal from the unreserved public lands in Alaska.

Who may mine coal for sale.—All permittees may mine coal for sale except railroads and common carriers, who by the terms of section 3 of the act are restricted to the acquirement of only such an amount of coal as may be required and used for their own consumption.

Duration of permits.—Permits will be granted for two years, beginning at date of filing, if filed in person or by attorney, or date of mailing, if sent by registered letter, subject to the approval of the Commissioner of the General Land Office, and upon application and

satisfactory showing as to the necessity therefor, may be extended by the commissioner for a longer period, subject to such conditions necessary for the protection of the public interest as may be imposed prior to or at the time of the extension. Misrepresentation, carelessness, waste, injury to property, the charge of unreasonable prices for coal, or material violation of such rules and regulations governing operation as shall have been prescribed in advance of the issuance of a permit, will be deemed sufficient cause for revocation.

Limitation of area.—The act limits the area to be covered in any one permit to 10 acres. It is not to be inferred from this, however, that the permits granted thereunder shall necessarily cover that area. The ground covered by a permit must be square in form and should be limited to an area reasonably sufficient to supply the quantity of coal needed.

Scope of permit.—Permits issued under section 10 of the act of October 20, 1914, grant only a license to prospect for, mine, and remove coal free of charge from the unreserved public coal lands in Alaska, and do not authorize the mining of any other form of mineral deposit, nor the cutting or removal of timber.

How to proceed to obtain a permit.—The application should be duly executed on Form 4—020, and the same should either be transmitted by registered mail to, or filed in person with, the register and receiver of the United States land office of the district in which the land is situated. Prior to the execution of the application the applicant must have gone upon the land, plainly marked the boundaries thereof by substantial monuments, and posted a notice setting forth his intention of mining coal therefrom. The application must contain the statement that these requirements have been complied with and the description of the land as given in the application must correspond with the description as marked on the ground. The permit, if granted, should be recorded with the local mining district recorder, if the land is situated within an organized mining district.

When coal may be mined before issuance of a permit.—In view of the fact that by reason of long distances and limited means of transportation many applicants may be unable to appear in person at the United States land office to file their applications, it has been deemed advisable to allow such applicants the privilege of mining coal as soon as their applications have been duly executed and sent by registered mail to the proper United States land office. Should an application be rejected, upon receipt of notice thereof all privileges under this paragraph terminate and the applicant must cease mining the coal.

Action by register.—The register will keep a proper record of all applications received and all actions taken thereon in a book provided for that purpose. If there appear no reason why the application should not be allowed, the register will issue a permit on the form provided for that purpose. Should any objection appear either as to the qualifications of the applicant or applicants, or in the substance or sufficiency of the application, the register may reject the application or suspend it for correction or supplemental showing under the usual rules of procedure, subject to appeal to the Commissioner of the General Land Office. Upon the issuance of a permit the register will promptly forward to the Commissioner of the General Land Office, by special letter, the original application and a copy of the

permit, and transmit copies thereof to the Chief of the Alaskan Field Division, and to the local representatives of the United States Bureau of Mines, for their information.

NOTE.—These regulations are intended merely as a temporary arrangement to meet immediate necessities, as authorized by section 10 of the act of October 20, 1914, and are not to be construed as applying to the leasing of public coal lands in Alaska provided in other sections of the act.

APPLICATION FOR COAL-MINING PERMIT.

_____

_____, 191

The Commissioner of the General Land Office,
Washington, D. C.

SIR: The undersigned, _____
(Name of applicant.)

of _____, hereby appl for a permit to
(Post-office address.)
prospect for, mine, and remove coal from the following-described land:

(Describe the land by legal subdivision if surveyed, and by metes and bounds with reference to some permanent natural landmark if unsurveyed.)

containing approximately _____ acres, situated within the _____ land district, _____ miles _____ of _____
(Direction.)
Alaska, and in support of this application make the following representation as to qualifications to receive a permit: _____
(Citizenship of applicant or applicants must here be shown. If the applicant is a municipality or corporation, it must be shown under what laws it is organized; and if the latter, it must also be shown whether a majority of its stock is owned and held by citizens of the United States.)

The applicant further represent that _____ ha not,
(He, they, or it.)
within two years last past, applied for or received a permit to mine coal under the provisions of section 10 of the act of October 20, 1914, in the coal field in which the land described in this application is situated, _____
(State exceptions here, if any.)
and that the coal herein applied for is to be mined for the purpose of supplying the following demands, for which approximately _____ tons are required annually: _____
(Here itemize the various uses to which the coal is to be applied, stating the number of tons necessary for each use.)

It is further represented that the boundaries of the tract described in this application have been plainly marked by substantial monuments, and that a proper notice describing the land and showing the intention of the applicant to apply for a free permit to mine coal therefrom has been posted in a conspicuous place upon the land.

On consideration that a permit be granted, the applicant hereby agree :

1. To exercise reasonable diligence, precaution, and skill in the operation of the mine, with a view to the prevention of injury to workmen, waste of coal, damage to Government property, and to comply substantially with the instructions and the rules and regulations printed on the back of this application.

2. To charge only such prices for coal sold to others as represent a fair return for the labor expended and reasonable earning value to which the investment in the enterprise is entitled, without including any charge for the coal itself.

3. Not to mine or dispose of, either directly or indirectly, any coal from the area covered by said permit for export or any purpose other than "strictly local and domestic needs for fuel."

4. To leave the premises in good condition upon the termination of the permit, with all mine props and timbers in the mine intact, and with the underground workings free from refuse and in condition for continued mining operations.

Signature of applicant _____

The foregoing application was signed by _____

_____

of _____, the applicant therein, in the presence of the undersigned, who, at _____ request and in _____
(His or their). (His or their.)
presence and in the presence of each other, have subscribed our names as witnesses to the execution thereof.

Dated this _____ day of _____, 19 , at _____
Territory of Alaska.

Name _____ Residence _____
Name _____ Residence _____

There were no important developments in the Alaska oil fields during 1915. The company that has been producing oil and making gasoline at Katalla went into the hands of a receiver and was reorganized. Operations were not interrupted, however, and the production of crude petroleum and gasoline was continued as in previous years. According to current reports an oil seepage was discovered in northern Alaska near Wainwright Inlet, about 100 miles southwest of Point Barrow. (See Pl. I.) If this report is confirmed, it is probably a western extension of the oil field southwest of Smith Bay.[1]

As the Alaska petroleum is a refining oil similar to that of Pennsylvania and has a high percentage of volatile compounds, the present market conditions would seem to justify the systematic prospecting of the more accessible fields of the Territory. No doubt if the fields are opened by a leasing law such as is now under consideration this work will be undertaken. Meanwhile large quantities of petroleum and petroleum products are annually shipped to Alaska, as shown in the following table:

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

Petroleum products shipped to Alaska from other parts of the United States, 1905–1915.

Year.	Oil used for fuel, including crude oil, gas oil, residuum, etc.	Gasoline, including all lighter products of distillation.	Illuminating oil.	Lubricating oil.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*
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	2,685,943	513,075	271,981
	147,258,988	15,681,791	6,432,669	1,421,668

STRUCTURAL MATERIAL AND MISCELLANEOUS MINERAL PRODUCTS.

Two marble quarries, one in Ketchikan and one in the Wrangell district, and one gypsum mine, in the Sitka district, were operated in southeastern Alaska during 1915. Some shipments of barite were made from a deposit on the west coast of Prince of Wales Island, and the garnet mine near Wrangell was operated during the year. Some graphite deposits in Seward Peninsula were prospected, but no shipments were made from them.

REVIEW BY DISTRICTS.

The subjoined review is intended to summarize briefly the principal developments in all the districts. The information at hand about mining in some of the districts is very 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.

Thirteen gold-lode mines, including several which made only a small output, six copper mines, three placer mines, two marble quarries, and one gypsum mine were operated in southeastern Alaska in 1915. Besides these operations some shipments of garnet and barite were made. The value of the mineral production from these mines is as follows: Gold, $5,435,586; copper (1,728,182 pounds), $302,431; silver, marble, lead, gypsum, etc., $352,554; total, $6,090,571. Details in regard to the mining developments are presented elsewhere in this report.

YAKATAGA DISTRICT.

About 20 men were engaged in mining the beach placers at Yakataga during 1915. It is reported that they had an unusually successful season. The White River hydraulic mine, also in the Yakataga district, was operated during the mining season.

COPPER RIVER REGION.

Mining in the Copper River region includes the development of the copper mines in the Kotsina-Chitina copper belt and placer mining in the Nizina, Kotsina, and Chistochina districts. In 1915 three copper mines were operated throughout the year and during the summer about 18 placer mines were worked.

At the Bonanza-Kennicott copper mine some 5,540 feet of underground development work was done during the year, and the ore has been opened up to a depth of about 600 feet. At the Jumbo-Kennicott 4,240 feet of underground work was done. The 400-foot level has been opened, and the sinking of the shaft to the 500-foot level is under way.

Work was continued on the Mother Lode copper mine throughout the year. The total underground developments now include some 5,040 feet of mine workings, of which 2,480 feet was opened in 1915.

Although the three mines above mentioned were the only ones commercially productive, the high price of copper has stimulated development throughout the field. Work is reported to have been continued on the claims of the Alaska Copper Corporation, on Nugget Creek; the Hubbard & Elliott Co., on Elliott Creek; and the Lakina Copper Co., on Lakina River. Developments were also made on the Berg property, in the Kuskulana Valley, and on the Copper Mountain property, near Kennicott. Undoubtedly work was done on many other copper claims about which no information is available at this time.

It is reported that a molybdenite-bearing quartz vein was discovered in 1915 on Canyon Creek, a northerly tributary of Chitina River above the Nizina, about 50 miles from McCarthy.

Five hydraulic plants were operated in the Nizina district during the open season. There were some shipments of placer copper from the district. There were also some smaller placer operations in the Nizina and Bremner districts. About 10 placer mines were operated in the Chistochina district during the summer. As in previous years, the largest operations were on Slate Creek and Miller Gulch. Gold to the value of about $200,000 was taken from the placer districts of the Copper River region in 1915, and about 150 men were employed.

PRINCE WILLIAM SOUND.

Four copper mines and five gold-lode mines were operated on Prince William Sound in 1915. The value of the total mineral production from this region, including gold, copper, and silver, was $1,340,996 in 1915, compared with $1,198,742 in 1914. Details in regard to mining developments on Prince William Sound are presented elsewhere in this volume.

KENAI PENINSULA.

Preparations for placer mining on a larger scale than in previous years were continued on Kenai Peninsula during 1915. For the most part these developments did not reach a productive stage, though there was an increase in placer mining compared with previous years. Prospecting of dredging ground continued, but the dredge on Kenai River was idle in 1915, and the one on Six-mile Creek was operated for only a short time.

The prospecting of auriferous lodes continued, but there were no notable developments of this form of mining. Some work was also done on stibnite deposits, though, so far as known, no shipments of antimony ore were made. It is reported that an antimony lode was discovered on Bear Creek during the year, and there is also an occurrence of stibnite on Kenai Lake which has long been known.[1]

Unfortunately, some of the mine operators in Kenai Peninsula fail to make returns of production and developments, hence no exact figures on the gold output are available. The information at hand indicates that gold to the value of about $88,123 was produced in 1915, of which $70,000 is to be credited to the placer mines. It is believed that about 25 placer mines were commercially productive, and some gold was also won incidentally to the prospecting of other properties. About a dozen hydraulic plants, large and small, were operated during the mining season, which in Kenai Peninsula is about 150 days in length. The largest plants are on Crow,[2] Bear, Resurrection, and Canyon creeks, but placer mining was also done on Sixmile, Miller, Quartz, Cooper, Winner, Gulch, and Lynx creeks. A dredge was built on Sixmile Creek and operated for a short time. A steam shovel was installed on Resurrection Creek toward the end of the mining season.

Some production was made from four auriferous lodes, besides smaller outputs from other properties incidentally to development work.

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[1] Martin, G. C., Johnson, B. L., and Grant, U. S., Geology and mineral resources of Kenai Peninsula, Alaska: U. S. Geol. Survey Bull. 587, p. 179, 1915.

[2] The output of the hydraulic mine on Crow Creek is included with that of the Kenai Peninsula placers, though it is located north of Turnagain Arm.

At the Bluebell mine work has been continued on two adits, which have reached a total length of 350 feet. A small mill on this property was operated for a part of the time. Work was continued at the Kenai-Alaska on the 200-foot level, and a total of 385 feet of underground work was done during the year. The 5-stamp mill was operated from August to November. About 75 feet of drifting was done at the Lucky Strike mine. The plant, including a 1-stamp mill, was operated from May to October. In the Moose Pass region developments were continued on the Gilpatrick claims. Considerable development work was also done on the Skeen-Stevenson property, in the same region, and some rich ore was found, which was treated in an arrastre. Besides the work noted above assessment and development work was done on many other lode claims.

Some coal was produced at the Bluff Point mine, on Cook Inlet, during 1915. Coal beds located near Point Woronzof and near McNeil Creek, both on the west side of Kenai Peninsula, were also prospected.

SUSITNA-MATANUSKA REGION.

The productive mineral resources of the Susitna-Matanuska region include those in the Willow Creek gold-lode district and the Yentna and Valdez Creek placer districts. A little placer mining has also been done on Willow Creek and on tributaries of the upper Chickaloon. Three gold lode mines and 25 placer mines were operated in this region during 1915 and produced gold to the value of $317,267. The three lode mines are in the Willow Creek district, where there is also one placer mine, which is described elsewhere in this volume. About twenty placer mines were operated in the Yentna district and five in the Valdez Creek district, employing about 90 men in all. The largest operations were those of the Valdez Creek Placer Mining Co., which operated a large hydraulic plant.

SOUTHWESTERN ALASKA.

No direct information as to the mining developments in the Iliamna region, Kodiak Island, or the Alaska Peninsula is available. It is known, however, that beach mining continued on Kodiak and Popof islands on about the same scale as in previous years. There were probably some lode developments in the Iliamna region and on Kodiak Island. The sulphur deposits of Makushin volcano, on Unalaska Island, have been prospected to some extent.

YUKON BASIN.

GENERAL FEATURES.

The value of the placer-gold output of the Alaska Yukon districts in 1915 is estimated to have been $7,050,000, compared with $7,570,000 in 1914. About 460 placer mines were operated in 1915, giving employment to about 2,900 men. Only three lode mines were productive in the Yukon basin in 1915, and these were all in the Fairbanks district, but several other lode properties produced some gold incidentally to development. The following table gives the estimated gold output of the principal Yukon placer camps in 1915:

Estimated value of gold produced from placers in the Yukon basin, 1915.

District.	Value.	District.	Value.
Fairbanks	$2,450,000	Koyukuk	$290,000
Iditarod	2,050,000	Circle	230,000
Ruby	700,000	All others	720,000
Hot Springs	610,000		
			7,050,000

The Yukon placer mines also produced $31,118 worth of silver. The above figures do not include the output of the lode mines, which in 1915 produced gold to the value of $217,776 and silver to the value of $910. There was also a small output of tin from the Hot Springs district (see p. 27), and considerable antimony ore was shipped from Fairbanks district (see p. 29). The total value of the entire mineral production from the Alaska Yukon in 1915 was $7,423,352.

FAIRBANKS DISTRICT.

The first placer mining in the Fairbanks district consisted of some small operations in 1903. Owing to the exhaustion of the bonanza deposits the placer-gold output has been on the decline since 1908. In these 13 years of mining gold to the value of about $65,490,000 has been won from the placers. The production of gold and silver from the placers is shown in the following table. Silver occurs as an impurity in the placer gold, and the figures given for silver are based on an estimate of its percentage.

Placer gold and silver produced in the Fairbanks district, 1903–1915.

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
	3,168,078.75	65,490,000	601,066	328,402

The data relating to the source of 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, 1903–1915.

Cleary Creek and tributaries	$22,270,000
Goldstream Creek and tributaries	13,050,000
Ester Creek and tributaries	10,680,000
Dome Creek and tributaries	7,570,000
Fairbanks Creek and tributaries	6,970,000
Vault Creek and tributaries	2,510,000
Little Eldorado Creek	1,870,000
All other creeks	570,000
	65,490,000

The above tables show only the placer output of the district immediately tributary to Fairbanks. They do not include the output of Bonnifield, Tenderfoot, Salchaket, and other smaller camps which are supplied from Fairbanks and whose gold is sent to Fairbanks. Several other districts, such as Hot Springs and Ruby, send a part of their gold output to Fairbanks. All these districts have contributed from $500,000 to $1,000,000 of gold to the total which annually passes through Fairbanks.

Lode mining began at Fairbanks in 1910, and since that time gold to the value of $1,068,845 has been produced by this industry. Therefore, the total gold production of Fairbanks district, including both lode and placer production, is about $66,500,000. The lode output is shown in the following table, which is based on more accurate data than those used for the placer production:

Lode gold and silver produced in the Fairbanks district, 1910–1915.

Year.	Total quantity of 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	349,457	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
	30,339	51,705.39	1,068,845	10,395	5,959

It is estimated that about 115 placer mines were operated in the district during 1915, employing about 1,050 men. Of the total value of the placer gold produced about $500,000 was taken out during the winter. The mines of Cleary Creek basin and adjacent parts of the Chatanika Flats are still the largest producers, but those

of Goldstream Creek and its tributaries, including Pedro and Gilmore creeks, made nearly as large a gold output in 1915.

The placers on lower Cleary, Vault, Dome, and Eldorado creeks occur as deep channels, so that here the mining is done by underground methods. On Goldstream, Pedro, Gilmore, and Fairbanks creeks the operations are carried on chiefly by open-cut methods, and the steam scraper is largely used. On Ester Creek both open-cut and deep mining is practiced. The dredge on Fairbanks Creek was operated throughout the season. The success of this enterprise should encourage the investigation of the many other large deposits of auriferous gravels in the district which are of too low grade to mine by the methods now in use. No doubt larger mining ventures will be undertaken as soon as the Government railroad now being constructed to Fairbanks cheapens the cost of fuel and other operating expenses. Meanwhile there is little hope that the placer mining industry will expand. During the last two years many of the operators have been developing the narrower pay streaks on smaller creeks that were formerly believed not to be available for economic exploitation. Last summer such mining was done on Wolf, Chatham, Happy, Eva, Wildcat, Big Eldorado, Steamboat, Flume, Twin, and other small creeks, and a considerable quantity of gold was produced. Another significant feature of the year's operations was the reworking of a claim in the middle part of Cleary Creek by open-cut methods. Though this claim was said to have been worked out years ago, the new operations yielded good returns. There is no doubt that a large amount of gold left in many of the mines that have been worked in the past, especially where it is not too deep for mining by open cuts, will in the future be taken out. The presence of large bodies of gravel carrying less gold than can be recovered under existing conditions is too well known to need mention again.[1]

The conditions that have led to a decline in placer mining have also halted the exploitation of lodes. There is no hope of the development of a lode-mining industry until operating costs are reduced. In spite of the adverse conditions, some lode miners have persisted, and it is entirely due to the enterprise of a few individuals that the Fairbanks district may still be classed as a lode camp.

The salient feature of the lode development in 1915 was the shipment of some 685 tons of antimony ore mined on four properties. This development of stibnite ore was possible only because of the high value of antimony and the low freight rates offered by the transportation companies to San Francisco, to which all the ore was shipped. The stibnite deposits of Fairbanks have been described in detail elsewhere [2] and need not be considered here. (See also p. 29.)

[1] Prindle, L. M., A geologic reconnaissance of the Fairbanks quadrangle, Alaska, with a detailed description of the Fairbanks district, by L. M. Prindle and F. J. Katz, and an account of lode mining near Fairbanks, by P. S. Smith: U. S. Geol. Survey Bull. 525, 1913.

Brooks, A. H., The future of gold placer mining in Alaska: U. S. Geol. Survey Bull. 622, pp. 69–79, 1915.

[2] Brooks, A. H., Antimony deposits of Alaska: U. S. Geol. Survey Bull. 649 (in press).

During 1915 three auriferous lode mines were operated on a regular productive basis in the Fairbanks district. These are the Rhoads & Hall, on Cleary Creek, and the Gilmore & Stevenson and Crites & Feldman, on Fairbanks Creek. There was also considerable development on other properties, incidentally to which some gold ores were produced from at least half a dozen. The ores were treated at small customs mills.

The Rhoads & Hall mine and mill were operated to September 10 and then were closed until cheaper operating costs insure greater returns. Most of the mining done in 1915 was on the first level, and about 200 feet of underground work was completed. Some of the tailings were treated in a small tube mill of local manufacture. The Crites & Feldman mine and mill were operated throughout the year. The mine is developed by two adits, the upper of which is 700 feet and the lower 400 feet long, and is equipped with a 5-stamp mill, an air compressor, and a sawmill. Most of the ore milled in 1915 came from the lower level. Nars, Anderson & Gibbs have continued work on their claims at the head of Moose Creek, a tributary of Fairbanks Creek. The developments consist of a 100-foot shaft and a 100-foot adit. Gilmore & Stevenson installed a 5-stamp mill on upper Fairbank Creek, which was operated from September 1 to the end of the year. This mill was supplied with ore from the Ohio group of claims, as well as from other properties in the vicinity. At the North Star claims near by a 30-foot incline was sunk, 60 feet of drifting on the vein was done, and some ore was milled.

Developments were continued on the Mizpah and adjacent claims, also in the upper valley of Fairbanks Creek. Some ore was produced and treated at a small customs mill near by. A 100-foot shaft has been sunk on the Rob & Roy claims, at the head of Too Much Gold Creek, a tributary of Fairbanks Creek. In addition 170 feet of drifting was done on the 70 and 100 foot levels and some ore was produced and milled.

At the American Eagle claim, at the head of Fairbanks Creek, a shaft 107 feet deep has been sunk, and an adit planned to cut the vein underground has been driven about 400 feet. Some work is also reported by the Territorial mine inspector [1] on the McCarty property, at the head of Fairbanks Creek; at the Homestake mine, at the head of Wolf Creek; at the Colorado claims, on Bedrock Creek; and at the Soo and Wild Rose claims, on Dome Creek.

An adit about 30 feet long was driven on the Independence claim, on Twin Creek. Here the bedrock is coarse porphyritic granite,

[1] Maloney, William, Report of the Territorial mine inspector to the governor of Alaska for the year 1915, pp. 14–15, Juneau, 1916.

and the lode consists of a zone of fracture striking about east and standing vertical, which has been permeated and mineralized by vein quartz. The quartz veins appear to be lenses or wedge-shaped masses cut off by joint planes that are nearly at right angles to lode. These joint planes are themselves mineralized, and some of the joints are filled with vein quartz. The rock breaks out in rhombohedral forms, including both quartz and mineralized granite. At the face of the adit in September, 1915, 3 to 4 feet of quartz and more or less mineralized granite were exposed, bounded on the north by a well-defined wall but having no sharp line of demarcation on the south side. Within this 3 or 4 feet there is probably a total of 12 to 15 inches of quartz exposed, occurring in several stringers. Martin Harrais, the owner, reports that the quartz stringers assay as high as $38 a ton and the mineralized zone from $4 to $22 a ton. About three-quarters of the gold is said to be in the concentrates. The vein has been traced about 1,500 feet east of Twin Creek, to the granite and schist contact. It has also been found in the schist, but this part of it is reported to carry no gold. The vein quartz is glassy to white in color and includes some well-developed crystals. Besides the gold the vein carries pyrite, arsenopyrite, and galena.

Though there are a number of promising quartz veins in the Ester Creek basin, only a few claims were under development during 1915. The principal developments in this part of the field were on claims owned by Tyndall, Finn & McGlauglin, and most of the work was done on the Bondholder group and on Mohawk claim. The Mohawk claim is developed by two shafts, one of which was examined and is about 50 feet deep. In this shaft a well-defined lode 2 feet or more in width is exposed. On the Bondholder claim work was continued on the lower adit, which is now nearly 600 feet long. It cuts some narrow mineralized shear zones, but the main lode has not yet been reached. Work was also continued on the claims controlled by McGlone & Smith, which adjoin those of Tyndall & Finn, but details in regard to this work are lacking.

In September, 1915, Albert Johnson discovered a lode carrying scheelite (tungstate of calcium) on the divide between the heads of Gilmore and Smallwood creeks, about 15 miles northeast of Fairbanks. This deposit has not been examined by any member of the Survey, but Mr. Johnson has kindly furnished a very complete description of it, on which the following notes are based.

The country rock in the vicinity of the discovery is schist, but the tungsten lode is in a bed of crystalline limestone 25 to 50 feet wide. It occurs close to a greenstone band, which is described as a dike intruded along the contact of the schist and limestone. The lode

itself, which appears to be a pegmatite intrusive, occurs within the crystalline limestone. It strikes about east and dips 40° N. and has been traced on the surface by pits for a distance of some 200 feet. So far as determined, the lode ranges from a few inches to 4 feet in width. It has been opened to a depth of 40 feet by an incline, along which it is reported to be about 4 feet wide for the full depth.

A specimen of the ore furnished by Mr. Johnson showed it to be made up of quartz, augite, scheelite, apatite, titanite, and a little biotite and hornblende, the last three chloritized. This rock appears to be a pegmatite in which the scheelite is a primary mineral. The scheelite is said to occur in part in small rich lenses or shoots, but most of the ore is of concentrating grade. Mr. Johnson reports that one analysis of concentrates yielded 72.82 per cent of tungsten trioxide. Though this is the only tungsten lode yet discovered in the district, the occurrence of scheelite in some of the Fairbanks placers has been reported. Scheelite is not, however, as common a mineral in this district as it is in some of the placers of Iditarod and Nome.

CHISANA DISTRICT.

About 17 mines were operated in the Chisana district during the summer of 1915 and 2 in the previous winter. These employed about 110 men in the summer and 8 in the winter. The total gold output of the camp was $160,000, of which about $150,000 came from the placers of Bonanza Creek. Sluicing began on June 25 and continued until about the middle of September. There was, however, some interruption owing to the lack of water because of a dry season. Besides the operations on Bonanza Creek mining was done on Little Eldorado, Skookum, Gold Run, Big Eldorado, and Coarse Money creeks. A high-line ditch was surveyed and partly built on Bonanza Creek.

FORTYMILE AND EAGLE DISTRICTS.

It is estimated that during 1915 about 30 placer mines were operated in the Fortymile and Eagle districts, employing about 110 men. In addition to this work many men were engaged in prospecting, and as usual a number were employed in working on the bars of Fortymile River and produced some gold. Exact information in regard to the value of the gold output is lacking, but it is probably about $90,000.

In the Fortymile district the principal producing creeks are Wade, Chicken, and Lost Chicken. There was also some mining on Ingle, Camp, Squaw, and Flat creeks and Franklin Gulch. Good prospects are said to have been found on Liberty Creek but are undeveloped. Plans are said to have been made to develop some placers on Dome Creek, a tributary of O'Brien Creek. Some deep holes were sunk on the benches of Wade Creek with a view of finding a

buried channel. A steam scraper was operated on Squaw Creek. Besides the usual number of "snipers" there were some larger mining plants along Fortymile River. These include some extensive ground-sluicing outfits near Atwater Bar, a steam scraper below Steel Creek, and a small hydraulic plant near by.

In the Eagle district three mines were worked on American Creek, and mining was continued on about the same scale in the Seventymile region as in the previous year. A new discovery of placer gold is said to have been made on Fox Creek, in the Seventymile basin.

CIRCLE PRECINCT.

The Circle precinct includes the Birch Creek district and the placers of Woodchopper and Beaver creeks. It is estimated that gold to the value of $230,000 was produced here from 50 mines employing some 200 men. The principal event of the year was the installation of a new dredge on Mammoth Creek, which began operations about June 1 and continued to the end of the season. This dredge is equipped with buckets of 3½ cubic feet, has a daily capacity of 2,000 cubic yards, and is capable of digging ground 15 feet deep. Wood is used as fuel. Hydraulic plants were operated on Switch, Mastodon, Deadwood, and Eagle creeks; deep gravel mining was done on Woodchopper, Coal, and Deadwood creeks; and open-cut operations on Woodchopper, Coal, and adjacent creeks were unusually successful. The largest output came from Mammoth Creek, and the largest number of operations were on Deadwood Creek.

TOLOVANA DISTRICT.

Workable gold placer ground was discovered on Livengood Creek, in the Tolovana district, July 24, 1914. As a result, there was a considerable influx of prospectors and miners into the new district during 1915. A deep channel was opened on Livengood Creek and traced for several miles, and this has been the source of most of the gold produced. There has been, however, some open-cut mining on tributaries of Livengood Creek and also on Olive Creek, which flows directly into Tolovana River. Good prospects have also been found in the adjacent Hess Creek basin, but here there was no productive mining.

It is probable that about 40 or 50 claims were more or less sytematically prospected in this district during 1915. Of these about 10 can be classed as productive mines, which produced gold to the value of about $80,000. Livengood (see Pl. I, in portrait), the distributing point of the district, has a post office, a wireless station, and a United States commissioner's office. It can be reached by a horse trail and winter road about 55 miles long from Olnes, a railway sta-

tion near Fairbanks. Another route available in summer is by launch up Tolovana River to the Log Jam and thence overland. The Log Jam is about 15 miles from Livengood. A more detailed account of the Tolovana district will be found elsewhere in this bulletin.

HOT SPRINGS DISTRICT.

About 30 placer mines, employing some 275 men, were operated in the Hot Springs district during the year. These yielded gold to the value of about $610,000, and incidentally some stream tin was won from the placers. The tin developments are described on pages 27–28. The most important development was the opening and mining of some placers on the lower part of Woodchopper Creek. Large plants were also operated on Oakley Creek, on the Lieber & File claims, Midnight Sun group, and on American Creek. A large hydraulic plant was operated on Eureka Creek, in the northern part of the district. There were smaller operations on Miller, Cache, Boulder, Sullivan, Patterson, Dalton, and Gold Run creeks. Much of the mining in this district is that of deep channels, in which operations are carried on both in summer and winter.

RAMPART DISTRICT.

Mining continued in the Rampart district on about the same scale as in recent years. In the district proper about 15 mines were operated on Hunter, Little Minook, Hoosier, Slate, Big Minook, Quail, and Ruby creeks. Gold to the value of about $35,000 was recovered from these operations, which were all on a small scale. A little winter mining was done on several creeks. Summer operations were hampered by lack of water. Considerable prospecting was done in the Dall and Hodzana river basins, and some encouraging results were reported, though there was no productive mining.

KOYUKUK DISTRICT.

About 35 mines, employing probably 150 men, were operated during 1915 in the Koyukuk district, including the Indian River region. The gold produced in these operations is estimated to have a value of $290,000. Of this amount about $225,000 was taken from the deep mines during the winter. The deep mines of Hammond River made the largest production, but winter mining was also done on Nolan, Linda, and Gold creeks. Some of the Hammond Creek deep placer ground is wet and owing to lack of pumps of sufficient size could not be mined. In 1915 some 4-inch steam pumps were brought in, and their successful operation makes it probable that deep mining will increase in the district.

The largest summer production was obtained from the placers of Jay Creek, which were discovered in 1915. Jay Creek flows into Rye Creek, which is a tributary of Wild River. The pay streak is said to be about 30 feet wide and 4 feet thick, and gold has been found on five claims. Placer prospects have also been found on Rye Creek. Nolan Creek made the second largest summer output, but productive mining was also done on Gold, Linda, Smith, Myrtle, and Crevice creeks. A little gold was won from the gravels of the South Fork and its tributaries. About $15,000 worth of gold was taken from the placers of Indian River and vicinity. This came chiefly from Indian River and its tributaries, but there was also a little mining on Black and Utopia creeks.

RUBY DISTRICT.

Sixty-one placer mines were worked in the Ruby district during 1915, and the value of the gold produced is estimated at $700,000. The most extensive mining was done on Long and Poorman creeks and their tributaries. The principal event of the year consisted in the preparations to install a dredge on Greenstone Creek, which will be in operation in 1916. Details in regard to the operations in this district are contained elsewhere in this volume.

INNOKO DISTRICT.

In spite of the dry weather during the summer, which resulted in some shortage of water, mining was active in the Innoko district. There was during the year a notable advance in the installation of larger mining plants than had been previously used, which augurs well for future gold production. It is estimated that 38 mines were operated in the Innoko district, including the Cripple Mountain region, during 1915, employing about 140 men and producing gold to the value of $190,000. This mining was done on Yankee, Little, Spruce, Ophir, and Ganes creeks, named in the order of the size of their gold output. Two steam scrapers were used on Yankee Creek, and a steam hoisting plant with self dumper on Spruce Creek. Late in the summer a small scraping plant was installed on Ganes Creek and operated for a short time. There was also some extensive prospecting with churn drill on Ganes Creek. Preparations were made for installing a hydraulic plant on Little Creek. There was considerable ditch building on Ophir and Spruce creeks. Some deep placer ground was found on Dodge Creek, and preparation was made for winter mining. Mining continued in a small way in the Cripple Creek Mountain region.

Twelve plants, employing about 40 men, were operated during the winter on Little, Ophir, and Ganes creeks and produced gold to the value of about $40,000.

IDITAROD DISTRICT.

Twenty-four mines were operated in the Iditarod district in 1915, employing about 400 men and producing gold to the value of $2,050,000. The largest operations were those of the two dredges on Flat and Otter creeks. There were also some extensive operations by open-cut methods on Otter Creek near Discovery, and large plants were operated near the heads of Flat, Chicken, and Happy creeks. The largest quantity of gold was obtained from Otter and Flat creeks.

A drag-line excavator, the first used in Alaska, was installed at a mine on Willow Creek during the summer and successfully operated. At this mine the frozen muck, about 10 feet deep, had during the previous year been ground-sluiced from an area about 1,500 by 100 feet, forming a cut to the gravels, which are 3 to 4 feet deep. It is this gravel which, having thawed out, is to be handled by the excavator and dumped into elevated sluice boxes. The machine has a 60-foot boom and a 1½ cubic foot bucket and is equipped with a 60-horsepower boiler. It is expected that the average daily capacity will exceed 1,000 cubic yards. This new method of mining, which promises to be a success, may have an important use in mining some of the Alaska placers.

No lode mining has been done in the Iditarod district, though some antimony-bearing quartz veins have been prospected.[1] Some of these deposits carry cinnabar, which with scheelite is abundant in some of the concentrates from placer mining. These antimony-cinnabar lodes, which also carry gold, are worthy of further prospecting. It is suggested that, on account of the present high price of tungsten, the placer miners might well consider the recovery of the scheelite from the concentrates. The placer-mining operations at the head of Flat Creek, on the Upgrade claims, have revealed some quartz stringers carrying considerable gold that cut the monzonite bedrock. Some of this material was dug out last year and shipped and represents the first production of lode gold from the Iditarod district. The distribution of placers at the heads of Flat, Happy, and Chicken creeks clearly indicates that there are zones of mineralization in the monzonite stock in which these creeks have their heads. It is possible that the gold may be sufficiently concentrated in some of these zones to justify lode development. In any event, there can be no question that there has been much auriferous mineralization in parts of this monzonite. The geology of the Iditarod district is discussed elsewhere in this bulletin.

[1] Brooks, A. H., Antimony deposits of Alaska: U. S. Geol. Survey Bull. 649 (in press).

SMALLER YUKON DISTRICTS.

In the Chandalar district there were no developments of importance in 1915. In the summer eight or ten men worked on about five claims and made a gold output of $4,000 to $5,000. The mining, as in previous years, was done on St. Marys, Squaw, and Big creeks. Some winter deep mining at the mouth of St. Marys Creek was planned. No lode mining was done, but some promising discoveries of auriferous quartz are reported.

About 10 mines, employing about 30 men, were operated in the Tenderfoot and Salchaket region. In this region mining is reported on Tenderfoot, Caribou, and No Grub creeks. There was also a little mining on Kenyon Creek, in the Healy River district. Some small placer-mining operations were continued in the basin of Chena River, which was the scene of considerable prospecting during the year. The above-mentioned operations yielded gold to the value of about $95,000.

Mining continued in the Bonnifield and Kantishna districts on about the same scale as in previous years, with a total gold production of about $40,000. Most of the mining is pick and shovel work, but some automatic dams and small hydraulic plants are in use. Some investigations were made during the year with the view of installing larger plants in the Kantishna district. The gold and antimony bearing lodes of this district[1] are also receiving some attention, though none are yet productive. In all, some 1,200 feet of underground work has been done on these lodes.

The Wade Hampton precinct lies in the lower Yukon basin, centering on the settlement of Marshall (see Pl. I), but the exact location of its boundaries is not known at this writing. Gold was discovered on Wilson Creek, which enters the Yukon at Marshall, in 1913. In the following year some claims were opened on this stream and on its tributary Disappointment Creek, and about $15,000 worth of gold was recovered. Meanwhile gold prospects had been discovered on several other creeks in the district. It is reported that in 1915 some seven claims were opened and that the gold produced had a value of about $25,000. In 1915 one placer claim on Wilson Creek, one on Disappointment Creek, and four on Willow Creek were worked by open-cut methods, and one bench claim on Willow Creek was worked by drifting.[2] Considerable prospecting was done during the summer with churn drills on Elephant Creek. A small quartz vein, said to carry considerable gold and silver, was found on Willow Creek, and a test shipment of ore was made. A vein carrying gold, galena, and

[1] Brooks, A. H., Antimony deposits of Alaska: U. S. Geol. Survey Bull. 649 (in press).

[2] Maloney, William, Report of the Territorial mine inspector to the governor of Alaska for the year 1915, p. 18, Juneau, 1916.

molybdenite is also said to have been found on the divide between Disappointment and Willow creeks.

KUSKOKWIM REGION.

Placer gold has been mined at several localities in the Kuskokwim region along an ill-defined belt stretching northeastward from the vicinity of Goodnews Bay for some 300 miles to Takotna River. (See Pl. I.) The northern part of this belt includes the Takotna district and the placers of the Georgetown region, described elsewhere in this volume. In the southern part are the Tuluksak-Aniak and Goodnews Bay districts.[1] In this zone also are some quicksilver deposits[2] on which some small developments were probably continued during 1915, though no reports about them have been received at this writing.

In the Tuluksak-Aniak district five claims were worked by 16 men on Bear, Spruce, Bonanza, and Marvel creeks. One small plant was operated on New York Creek, tributary to the Kuskokwim from the north, above the settlement of Aniak. The most important developments of the year in the lower Kuskokwim region were on Canyon Creek, which forms a part of the Kwikluk drainage basin. Here five mines were operated during the year, and some fairly rich placers were developed. There was also a little mining on Rainy and Kapon creeks in the same district. Good prospects are reported to have been found on Fork and Windy creeks, also in the Kwikluk River basin. The benches on Fork Creek are said to carry gold. Mining continued in the Goodnews Bay district on a small scale, as in previous years. The gravels of the lower Kuskokwim region are not frozen, and it appears that some of them are worthy of investigation for development by dredges.

It is estimated that in all about 25 mines were operated in the Kuskokwim region in 1915, employing about 80 men, and that they produced gold to the value of about $100,000. In addition to the men employed in productive mining, a larger number were engaged in prospecting and development work.

SEWARD PENINSULA.

The estimated value of the gold output from Seward Peninsula in 1915 is $2,900,000; that of the 1914 output was $2,700,000. Tin, antimony, and coal were produced on Seward Peninsula in 1915 to the value of about $84,000. Absolutely reliable statistics of gold production of the peninsula are far from being complete, but the following table, based on the best data available, gives an estimate of the yearly output since mining began in 1897.

[1] Maddren, A. G., Gold placers of the lower Kuskokwim, with a note on copper in the Russian Mountains: U. S. Geol. Survey Bull. 622, pp. 292-360, 1915.

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

Gold and silver produced in Seward Peninsula, 1897–1915.

Year.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
1897	725.63	$15,000	87	$52
1898	3,628.12	75,000	435	256
1899	135,450.00	2,800,000	16,254	9,752
1900	229,781.25	4,750,000	27,574	17,097
1901	199,822.61	4,130,700	24,579	14,747
1902	220,677.07	4,561,800	26,481	14,035
1903	215,994.38	4,465,000	24,171	13,052
1904	201,462.52	4,164,600	24,175	14,021
1905	232,200.00	4,800,000	27,864	16,997
1906	352,812.50	7,500,000	43,537	29,605
1907	338,625.00	7,000,000	25,497	16,828
1908	247,680.00	5,120,000	20,577	10,905
1909	206,077.50	4,260,000	20,871	10,853
1910	169,312.50	3,500,000	20,317	10,971
1911	149,962.50	3,100,000	17,996	9,718
1912	145,125.00	3,000,000	17,415	10,710
1913	120,937.50	2,500,000	12,094	7,305
1914	130,612.50	2,700,000	15,673	8,667
1915	140,287.50	2,900,000	17,510	8,878
	3,451,174.08	71,342,100	383,107	224,449

Most of this gold was taken from placers, although from 1903 to 1907 the Big Hurrah lode mine produced some gold, and small outputs have been obtained from several lodes at different times.

A small amount of silver-lead ore was shipped from the Omalik mine, in the Fish River basin, as early as 1881, and several other shipments of ore have been made from this property, but these are not included in the table. The silver output above noted has largely been recovered from the placer gold. The only other mineral resources of the peninsula that have been developed are some coal deposits in the Fairhaven district that have been mined in a small way since 1902; the York tin deposits, first developed in 1900; and the antimony deposits, first exploited on a commercial scale in 1915.

The most important advances made on the peninsula during the year were the revival of deep mining and the development of antimony lodes. Gold dredging continued on a large scale but was not as productive as in the preceding year. Thirty-one gold dredges were operated and handled about 3,000,000 cubic yards of gravel, yielding gold to the value of $1,050,000. In 1914, 39 dredges dug about 3,400,000 cubic yards of gravel and recovered $1,280,000 worth of gold. The total gold recovered by dredges since this method of mining was first introduced in 1903 has an estimated value of $8,850,000. Of the 31 dredges operated in 1915 two were engaged in mining placers in the York district that carry gold as well as tin. In addition to the gold dredges, two tin dredges were operated in the York district in 1915, making 33 dredges in all on Seward Peninsula. Three gold dredges and one tin dredge were built during the year.

The cause of the decrease in production of dredge gold is not clear, as there are known to be large areas of auriferous gravels [1] on the peninsula which appear to be suitable for profitable exploitation by dredges. One reason, however, is that most of the successful dredges appear to have worked on placers of rather high grade, and their success has been due to this fact rather than to economical mining by large operations. Little attempt has been made to work the permanently frozen placers, as has been so successfully done in the Alaska and Canadian Yukon. In the Yukon region wood costs from $9 to $14 a cord, which is less expensive per heat unit than the retail price of coal at Nome, about $20 a ton. The cost of fuel oil per heat unit is said to be still less. To this price must be added the expense of hauling the fuel to the dredge. It would seem that there is in Seward Peninsula a field for strong companies that could introduce economies in the operation of dredging and thawing.

Some placers were developed during 1915 in the southeastern part of the peninsula. It has long been known that placer gold occurs in this region,[2] but until recently mining has been only intermittent. The following notes on the new developments are based largely on information furnished by Mr. Lars Gunderson, who resides in the district.

The developed placers were on Dime Creek, which joins Koyuk River about 40 miles from Norton Bay by the windings of the stream. The bedrock of the district is schist with some crystalline limestone. Gold placers are said to have been found on nine contiguous claims on Dime Creek, which would mark a pay streak about 2 miles in length. Placer gold has also been mined at different times in the adjacent region.

Though little productive mining has yet been done on Dime Creek, nearly $3,000 is said to have been taken out of three claims. Some of the gold is said to be worth over $19 an ounce. A settlement has been established on Dime Creek, and provisions and mining supplies, including boilers, have been brought in. The systematic opening of the placer ground is therefore assured.

Including the gold dredges, it is estimated that 120 placer mines were operated on the peninsula in 1915, employing about 1,200 men. These do not include the placer tin mines, of which there were three, employing 40 men. The distribution of the gold production by districts is shown in the following statement, which, however, owing to the failure of some of the operators to make returns, is only an approximation.

[1] Collier, A. J., Hess, F. L., Smith, P. S., and Brooks, A. H., The gold placers of parts of Seward Peninsula, Alaska, including the Nome, Council, Kougarok, Port Clarence, and Goodhope precincts: U. S. Geol. Survey Bull. 328, pp. 111-135, 1908.

Brooks, A. H., The future of gold placer mining in Alaska: U. S. Geol. Survey Bull. 622, pp. 69-79, 1915.

[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, 1911.

Approximate distribution of gold produced in Seward Peninsula, 1915.

Nome district	$1,500,000
Council district	685,000
Fairhaven district	250,000
Solomon district	250,000
Kougarok district	140,000
Port Clarence and smaller districts	75,000
	2,900,000

More deep placer mining was done at Nome during 1915 than there has been for many years. About 36 deep placer mines, employing about 250 men, were operated in the Nome district during the winter of 1914–15, and the value of their gold output and that of the mines operated in summer was about $300,000. Though there was a shortage of water in the peninsula during August, in general the season was favorable to placer-mining operations.

The Sliscovitch mine was opened late in the summer, and some antimony ore was shipped from it. Some antimony ore was also shipped from the Hed & Strand mine, about 3 miles north of the Sliscovitch. Antimony-bearing lodes were prospected at other localities in the peninsula, notably on Anvil Creek. A summary of the antimony resources of the peninsula is in press.[1] The developments in tin mining are noted elsewhere in this volume. (See pp. 27–28.)

Some gold was probably recovered incidentally to the mining of antimony deposits, but there appears to have been no other lode production, though prospecting of auriferous quartz veins continued. A gold-bearing vein was found on Boulder Creek, in the Nome district, and is said to have been traced for a considerable distance. Plans are under way for prospecting this deposit.

KOBUK REGION.

Placer mining in a small way continued in the Kobuk region during 1915. Four claims were worked on Klery Creek, in the Squirrel River district, and four claims on Dall, Shungnak, and Lynx creeks, in the Shungnak district. An 8½-ounce nugget was found on Klery Creek. In the Shungnak district two dams with automatic gates were installed. The entire gold output of the Kobuk region is estimated to have a value of $20,000.

[1] Brooks, A. H., Antimony deposits of Alaska: U. S. Geol. Survey Bull. 649.