INVESTIGATION OF MINERAL RESOURCES OF ALASKA IN 1908.

By ALFRED H. BROOKS and others.

ADMINISTRATIVE REPORT.

By ALFRED H. BROOKS.

PREFACE.

The present bulletin is the fifth of the annual volumes [a] which both summarize the conditions of the mining industry in Alaska and record the more important economic results attained by the investigations during the year. The more elaborate reports, illustrated with maps, etc., are of necessity slow in preparation and publication, and hence the more important conclusions, so far as possible, are presented briefly in this preliminary form. These reports are intended to serve as handbooks of reference to those who are engaged in the mining industry within the Territory, though it is impossible, with the funds available, to collect complete information each year in regard to every district.

Although it is intended to present here only the conclusions established by the investigations and to leave to the more detailed publications the discussion of the more difficult problems, yet it sometimes happens that a geologist finds on the completion of his office work that he must modify his preliminary statement of results; hence the matter contained in this volume is not offered with the same degree of confidence as if the laboratory and office investigations had been finished. Nevertheless, the importance of making public the economic results of the surveys has appeared to justify the policy of printing these preliminary abstracts of reports not yet completed. Those interested in any particular mining district, however, are

[a] Report on progress of investigations of the mineral resources of Alaska, 1904: Bull. U. S. Geol. Survey No. 259, 1905; idem, 1905: Bull. No. 284, 1906; idem. 1906: Bull. No. 314, 1907; idem, 1907: Bull. No. 345, 1908.

cautioned to depend for detailed information on the more complete reports.

Three groups of subjects have been recognized in the arrangement of this volume, as in those previously issued—(1) summaries of progress of the various phases of the mining industry in different parts of the Territory during the year; (2) preliminary accounts of investigations in progress or completed; (3) statements of results of minor investigations made incidental to other field work and not to be published elsewhere.

In outlining mining conditions in parts of the Territory which could not be visited during the year by the small force of men available for the purpose recourse is had to various sources of information that are believed to be reliable. Such compiled data, however, are as a rule used solely as a basis for statements regarding the conditions of mining development. The discussion of the occurrence and distribution of the various types of mineral deposits is based on the field observations of the members of the Geological Survey, except in the few cases where what appeared to be reliable information could be obtained from other sources, such assistance being credited to the person furnishing it.

It would be impossible to record the advancement of the mining industry throughout the Territory were it not for the many men who have cooperated with the Survey in the collection of this information. These men include not only the large number of operators who have furnished statistics of their own production that have been utilized in making up the summary, but also the many persons who, by conference or correspondence, have furnished valuable information regarding fields which it was impossible to visit. To enumerate the individuals and corporations who have aided the investigations would be to give almost a complete roster of the mining men and corporations who have come into contact with the work of the Geological Survey. The writer feels, however, under special obligation to the following persons and companies, many of whom have been especially helpful in sending him data about the mining industry in isolated districts which were not studied during the past season by members of the Survey: E. T. McNally, of Sunrise; Milin Dempsy, of Chisna; G. M. Esterly, of Nizina; R. Blix, of Copper Center; William Grogg, of Valdez Creek; A. J. Childs, of Deadwood; Samuel Sim, of Circle; W. B. Ballou, of Hot Springs; H. L. Hedger, of Richardson; A. T. Whitehead, of Coldfoot; S. J. Marsh, of Caro; C. W. Thornton, of Nome; Lewis Lloyd and M. F. Moran, of Shungnak; the Alaska Commercial Company, and the Northern Navigation Company, who have furnished information in regard to both mining development and gold output, and C. D. Garfield, of Nome; Maj. J. P. Clum, the First National Bank,

the Washington Alaska Bank, and the Fairbanks Banking Company, of Fairbanks; and the Alaska Pacific Express Company, who have contributed statistical data in regard to gold production.

As in previous reports, much of this volume is devoted to a discussion of the gold placers, for these still form much the largest source of the mineral output. In this volume, however, it has been possible to give more space to some of the other phases of the mining industry. The lode mining of southeastern Alaska is treated, as heretofore, but the bulletin also includes accounts of the occurrence of copper in the Copper and White river regions and Prince William Sound, based on examinations made in 1908; a report on the new field of southwestern Alaska, which has some promising mineral deposits; a preliminary statement of the first detailed geologic surveys of the Fairbanks district; and an account of the Iron Creek region of the Seward Peninsula. Of particular interest to prospectors will be the report here presented on the Innoko region which previous to 1908 had not received any study by members of the Geological Survey. It is to be regretted that there are so many other districts where some mining development has taken place, but which it has not been possible to survey. Among the most important of these are the Valdez Creek region, the Iliamna Lake region, the Kuskokwim Valley, and the Chandalar and Koyukuk districts, in all of which a large amount of prospecting has been done.

Like the previous volumes, this one is made up mainly of papers written by the members of the Survey's division of Alaskan mineral resources. It contains nineteen different papers by fifteen authors. A general account of the mining industry forms the introductory paper of the report, and this is followed by a paper on the use of peat, by Charles A. Davis. This paper is presented in the belief that it may serve a useful purpose in drawing attention to the possibility of utilizing Alaska peat as a fuel. The remaining papers are arranged, so far as possible, geographically from south to north and from east to west. The importance of publishing this report without delay makes it necessary to limit the illustrations to a few outline maps. The complete reports, which are in preparation, will contain more elaborate illustrative matter, including both geologic and topographic maps.

PROGRESS OF SURVEYS.

INTRODUCTION.

Thirteen parties were engaged in Alaskan surveys and investigations during the season of 1908 for varying periods of time between March and November. Some of these parties were subdivided in the field, making a total of 17 parties that were engaged in various kinds of investigation. The personnel of these parties included 22 tech-

nical men and 20 to 25 camp hands. Of the technical men, 13 were geologists, 5 topographers, and 4 engineers. In addition to these, the geologist in charge spent a part of the summer months in Alaska, carrying on geologic investigations and visiting field parties. Four clerks were employed in the office for the whole or a part of the year.

The area covered by topographic reconnaissance surveys during 1908 aggregated 3,975 square miles; the detailed topographic surveys, 427 square miles. Detailed geologic surveys were made of 604 square miles, and geologic reconnaissance surveys over an area of about 4,850 square miles. In addition to the actual areal mapping most of the geologists spent considerable time in studying special problems connected with the mineral deposits. The investigation of the water supply in placer districts covered an area of 6,700 square miles and included 556 measurements of stream volumes at 53 gaging stations.

To present the matter geographically, two parties were in southeastern Alaska, of which one made detailed geologic surveys of two copper mining districts, while the other, a topographic party, was engaged in preparing a base map of the same region. In the Copper River region there were three parties, two of which were making detailed topographic surveys of one copper district, and the third a general geologic reconnaissance, with some topographic work, in another district. One geologic party was occupied for about three months during the summer in a geologic reconnaissance, with some incidental topographic surveys, in the Prince William Sound copper district. Similar work was carried on in the coal fields of southwestern Alaska. Five parties were at work in the Yukon placer district. Of these, one was making detailed geologic surveys; another, geologic and topographic reconnaissance surveys; a third, topographic reconnaissance surveys; the other two were engaged in stream gaging. In Seward Peninsula one party was engaged in geologic mapping, both detailed and reconnaissance; a second was working on general geologic and stratigraphic problems; and two more were engaged in stream gaging.

The following table shows the allotment (including both field and office expenses) of the total appropriation of $80,000 to the various districts investigated:

Allotments to Alaskan surveys and investigations, 1908.

Surveys and investigations, southeastern Alaska	$9,800
Surveys and investigations, Prince William Sound and southwestern Alaska	9,100
Surveys and investigations, Copper River region	20,000
Surveys and investigations, Yukon basin	27,950
Surveys and investigations, Seward Peninsula	13,150
	80,000

The following table shows approximately the amount of money devoted to each class of investigation. It is not possible to give the exact figures, as in some cases the same party, or even the same man, carried on two different kinds of work; but this statement will help to elucidate the later table, which summarizes the completed areal surveys:

Approximate allotment of Alaskan funds to different classes of surveys and investigations, 1908.

Geologic reconnaissance surveys	$14,100
Detailed geologic surveys	10,000
Special geologic investigations	8,900
Topographic reconnaissance surveys	12,200
Detailed topographic surveys	14,200
Investigation of water resources	9,900
Collection of statistics of mineral production	1,500
Miscellaneous, including clerical salaries, administration, inspection, instruments, and office supplies and equipment	9,200
	80,000

Under geologic reconnaissance surveys in the above table are included all those made for publication on a scale of 4 or 10 miles to the inch; the detailed geologic surveys are all for publication on a scale of 1 mile to the inch. The special geologic investigations are chiefly those directed to the study of problems connected with the occurrence of mineral deposits. The topographic reconnaissance surveys are chiefly for publication on a scale of 4 miles to the inch, usually with 200-foot contours, though some of an exploratory nature will be published on a scale of 10 miles to the inch. The detailed topographic surveys are for publication on a scale of 1 mile to the inch, with 25, 50, or 100 foot contours. The water-resources investigations have for their purpose the determination of the water supply available for placer mining.

The cost of the surveys of various types per square mile is affected by many factors that vary greatly in different parts of the Territory. Chief among these is the item of transportation, which varies in cost from 5 to 30 per cent of the total expenditure for surveys. The cost of the topographic reconnaissance surveys is from $2 to $4 per square mile; that of the detailed topographic mapping from $25 to $40 per square mile. These variations are partly due to the differences in cost of transportation to different districts and also to character of topography, vegetation, rainfall, length of open season, etc.

It is far more difficult to generalize on the cost of geologic surveys. All the variations which affect the cost of topographic mapping also influence that of geologic mapping. In addition there is a far more important factor in the intricacy of the geology and the knowledge

available regarding the problems involved, before the work has been begun. If the general features of the geology of any province are known, areal mapping can be carried on much more rapidly than if the province is entirely unexplored. Obviously, also, where the stratigraphic and areal relations are simple mapping can be carried on far more rapidly than where they are complex. It is therefore not surprising that the cost of geologic reconnaissance surveys varies as much as from 75 cents to $3.50 per square mile. Detailed geologic surveys have been carried over only a few small areas in Alaska, so that there are few data on which to base estimates of cost. The evidence in hand, however, indicates a cost of $14 to $34 per square mile for work of this class. Water-resources investigations, involving the measurement of stream volumes in the same district for a period of years, can not be estimated in cost per square mile.

Progress of surveys in Alaska, 1898–1908.[a]

Year.	Appropriation.	Areas covered (square miles).				Water-resources investigations.	
		Geologic.		Topographic.		Gaging stations maintained part of year.	Stream-volume measurements made.
		Reconnaissance.	Detailed.	Reconnaissance.	Detailed.		
1898	$46,189.60	9,500	.....	14,912	.....	.....	.....
1899	25,000.00	6,000	.....	8,688	.....	.....	.....
1900	25,000.00	10,000	.....	11,152	.....	.....	.....
1901	35,000.00	12,000	.....	15,664	.....	.....	.....
1902	60,000.00	17,000	.....	20,304	336	.....	.....
1903	60,000.00	13,000	336	15,008	.....	.....	.....
1904	60,000.00	6,000	.....	6,480	480	.....	.....
1905	80,000.00	8,000	550	8,176	948	.....	.....
1906	80,000.00	9,000	414	10,768	40	14	286
1907	80,000.00	4,000	400	6,125	501	48	457
1908	80,000.00	4,850	604	3,975	427	53	556
	631,189.60	99,350	2,304	121,252	2,732	.....	.....
Percentage of total area of Alaska	.....	16.94+	0.39+	20.85−	0.47−	.....	.....

[a] In addition to the above, the International Boundary Survey and the Coast and Geodetic Survey and other government bureaus have covered an area of approximately 50,000 square miles. Most of this work is along the coast line, and has been carried on with a high degree of refinement. The inland surveys are chiefly of a reconnaissance character, except for a narrow strip along the international boundary.

The above table indicates the progress of Alaskan surveys, so far as they can be presented in tabular form and in percentages of the total areas which have been mapped geologically and topographically. The progressive decrease in the area covered annually by reconnaissance surveys is largely due to the fact that since 1903 a large part of the appropriation has been spent for detailed surveys. As the detailed surveys cost from five to twenty times as much as reconnaissance surveys, naturally the total area surveyed for the same money is very much less. Hence, as there has been a growing demand for the detailed maps, there has been a corresponding decrease in areas cov-

ered by reconnaissance surveys. Another reason for the decreased areas now covered annually by surveys is the fact that during the first five years practically all the appropriation was spent on exploratory surveys, whereas now much of it is devoted to special investigations. Moreover, the early exploratory surveys were not executed with the same degree of refinement as the present reconnaissance work, and the results were published chiefly on a scale of 10 miles to the inch, as compared with 4 miles to the inch, the present publication scale.

To meet the demands of the mining industry, it does not seem advisable to devote a much larger proportion of the available money to reconnaissance surveys at the expense of detailed surveys and investigations, and therefore, under the present appropriation, the general work can not be extended any more rapidly than it has been during the past decade. As approximately a fifth of the Territory has been covered by reconnaissance maps, both topographic and geologic, it appears that it will require at least fifty years to cover the whole of the Territory with the preliminary mapping. It should be added, however, that the areas that have been chosen for survey are those of most importance to the mining industry, and that at least a fifth or a quarter of the remaining area may not require survey for many years to come. The fact remains, however, that there are about 200,000 square miles in Alaska which should be surveyed at an early date, and that under the present appropriation this can not be accomplished so as to do justice to the mining developments in less than two or three decades.

GEOGRAPHIC DISTRIBUTION OF INVESTIGATIONS.

GENERAL WORK.

The writer's field investigations covered a period from about the end of July to the middle of October. Of the time he actually devoted to field work, about two weeks was spent with Mr. Wright in going over the geology of Kasaan Peninsula, Karta Bay, and the Copper Mountain region—all on Prince of Wales Island. At the same time Mr. Sargent's topographic party, then surveying the Copper Mountain region, was visited. Later a trip to Fairbanks was made by way of the White Pass and Yukon River. Here about ten days was spent with Mr. Covert, Mr. Prindle, and Mr. Katz in becoming familiar with the problems connected with the detailed geology and mining development of the Fairbanks district. The latter part of the season was spent with Mr. Smith in a review of the areal geology of the Solomon and Casadepaga region, together with some reconnaissance work in adjacent regions.

In the office the writer has given most of his time to administrative and routine work, in which he was aided by T. C. Gerdine, who supervised the Alaskan topographic surveys until his transfer to the topographic branch of the Survey. His place was taken by R. H. Sargent. During the writer's absence in the field E. M. Aten looked after the office routine, and also rendered valuable services in the compilation of the mineral statistics of Alaska. Part of the month of June and most of the month of July was devoted by the writer to a continuation of the report on the Mount McKinley region. During the month of December he prepared a summary of the existing knowledge of the mineral resources of Alaska for the Conservation Commission.

SOUTHEASTERN ALASKA.

In 1907 the detailed geologic mapping of Kasaan Peninsula and the adjacent copper-bearing belts of Prince of Wales Island was begun, and this work was completed in 1908 by C. W. Wright. It included not only a study of the areal and stratigraphic geology, but also a detailed investigation of the ore deposits. Mr. Wright has also carried on a similar investigation over the Copper Mountain region, on Prince of Wales Island at the head of Hetta Inlet. The field work was accomplished between June 2 and October 22, about 90 square miles being mapped. These investigations represent the first detailed studies that have been made south of Juneau, and form a part of the general plan to make similar studies of all the important producing mining districts.

The results of Mr. Wright's preliminary studies in the Kasaan Peninsula were published last year;[a] the results of his investigations of 1908 are summarized in this volume (pp. 67–86); and his final report is in preparation. In addition, Mr. Wright has prepared a general statement of the condition of the mining industry throughout southeastern Alaska, to obtain data for which he devoted the last ten days of the season to visiting the more important mining fields not covered by his detailed work.

The base maps needed for the detailed geologic work above noted were begun in 1907, when a large part of Kasaan Peninsula and the adjacent areas were mapped by D. C. Witherspoon. The work was completed in 1908 by R. H. Sargent, who also mapped an area of 53 square miles in the Copper Mountain region. These surveys, for a publication scale of 1 inch to a mile (1:62,500), with 50-foot contours, were completed between May 6 and September 27. The resulting map will be published with Mr. Wright's final report.

[a] Bull. U. S. Geol. Survey No. 345, 1907, pp. 98–115.

COPPER RIVER REGION.

Last year a reconnaissance survey and reexamination of the copper deposits of the Kotsina-Chitina district was made by F. H. Moffit and A. G. Maddren. This investigation covered the southern copper belt, and while it must be regarded as incomplete, yet it furnished an important clue to the character of the ore bodies, and the resulting report (Bulletin 374) contains much information of value regarding this field. In accordance with the plans outlined, Mr. Moffit, associated with Adolph Knopf and assisted by S. R. Capps, during the past season did similar work along the northern copper belt, which extends from the head of Copper River across to White River. This field, like the southern belt, had previously been studied,[a] but the interest taken in the copper deposits necessitated further investigation. The party left Valdez on June 15 and reached the field of operations on July 8. The time up to September 9 was spent in studying the copper deposits and the areal geology of the region lying between the heads of Copper and White rivers. About 1,800 square miles was mapped geologically, and Mr. Capps also devoted one month to topographic surveys, covering an area of 450 square miles. The party returned by way of Skolai Pass into the Chitina Valley in September and there divided, one section coming to the mouth of Copper River by boat and the others going overland to Valdez. A preliminary statement of results is contained in this volume (pp. 161–180), and the final report is in preparation.

As detailed study of the copper deposits of this general province must be undertaken before the laws of their occurrence can be determined, and as such detailed studies require a base map, it was decided to prepare such a map of the east end of the Kotsina-Chitina belt. This area was chosen both because the exposures were such as to afford more data regarding the bed-rock geology than could be obtained elsewhere and because more development work had been done at this end of the Chitina belt than in any other part of the copper-bearing region. To this work D. C. Witherspoon, assisted by R. M. La Follette, was assigned. The party left Valdez about the end of March and on April 19 reached Nizina, to which point supplies had been shipped during the previous winter. This early start was made so that topographic surveys might be begun as soon as the snow was off the ground. The work was continued to September 10, when the party returned to the coast by way of Copper River. During this time an area of 325 square miles was topographically surveyed for publication on a scale of 1 mile to the inch, with contour intervals of 50 feet. It is proposed to use this base map for

[a] Mendenhall, W. C., and Schrader, F. C., The mineral resources of the Mount Wrangell district; Prof. Paper U. S. Geol. Survey No. 15, 1903.

geologic work during the coming year, and it is confidently hoped that the results will throw much light on the occurrence of ore bodies throughout the two copper belts.

PRINCE WILLIAM SOUND.

The Prince William Sound region has been the scene of several investigations by the Geological Survey, the latest previous to 1908 having been made by U. S. Grant in 1905. The extensive prospecting done in this field and the fact that it has been a large shipper of copper ore made further work imperative. Mr. Grant, assisted by D. F. Higgins, was, therefore, engaged to continue his investigations of this field and to complete the general reconnaissance of the ore deposits of Prince William Sound. He began field work on July 7 and continued it until August 23. Special attention was given to Latouche Island, where the mine which is the largest producer of the district is located. Here a detailed topographic and geologic map of an area of 8 square miles was prepared. As many of the prospects in the district were visited as time and circumstances permitted, and a general reconnaissance was carried over the western part of the sound. As a result of this work the general features of the geology have been determined, especially the occurrence of the ore bodies. In addition to the detailed topographic mapping of the upper end of Latouche Island, considerable geologic reconnaissance work was done along the west side of Prince William Sound, embracing an area of about 600 square miles (p. 87).

At the close of the season Mr. Grant also made a hasty examination of some of the ore deposits near Seward, on Kenai Peninsula, but unfortunately the field season was too short to permit an exhaustive study of the prospects of this district (p. 98).

SOUTHWESTERN ALASKA.

The plan of a general study of the coal fields of Alaska, which was inaugurated in 1906, was continued during 1908 by a reconnaissance survey of the coal fields of Alaska Peninsula. This work was in charge of W. W. Atwood, assisted by H. M. Eakin. Field work was begun on May 28 and continued until September 4. During this time topographic and geologic reconnaissance surveys of the more important parts of the Herendeen Bay, Unga Island, and Chignik coal fields were made. The total area surveyed was about 1,500 square miles. In addition to the study of the coals, Mr. Atwood also devoted considerable attention to the investigation of the various types of metalliferous deposits of the district. A preliminary account of his results is contained in this volume (p. 108) and a complete report is in preparation.

YUKON BASIN.

Last year a topographic survey was made of the Fairbanks placer district for the purpose of obtaining a base map for detailed geologic studies. These studies were carried on this year by L. M. Prindle, assisted by F. J. Katz, and between July 1 and September 13 they completed the geologic survey of the area covered by the base map (436 square miles) and made a detailed study of the occurrence of auriferous gravel. The complete report on this work is in preparation and a preliminary statement is contained elsewhere in this volume (p. 181).

To J. W. Bagley was assigned the task of completing the topographic reconnaissance map of the region lying north of Tanana River. Mr. Bagley reached the field of operations July 3, and continued work until September 18. He carried a survey eastward along the north side of Tanana River as far as the mouth of Healy River. The latter part of the summer was devoted to topographic mapping in the vicinity of the mouth of the delta south of Tanana River. In all an area of 1,725 square miles was covered. The results of these surveys will be embodied on the maps of the Circle and Fairbanks quadrangles, which will be published for sale as soon as funds are available.

In 1907 investigation of the water resources of the Yukon-Tanana district was begun in the Fairbanks region. During the past summer this work was extended by C. C. Covert, assisted by C. E. Ellsworth. For the purpose of obtaining data regarding the spring run-off when the melting of the snow takes place, Mr. Covert proceeded to Fairbanks over the ice, reaching there April 3. He devoted the early part of the season to a study of the water conditions of the streams tributary to the Chatanika, and later proceeded overland to the Circle district, where he met Mr. Ellsworth and party, who came inland by way of the White Pass. The remainder of the season to September 13 was devoted to a study of the water resources of the Circle, Fairbanks, Rampart, and Baker regions. Twenty-one gaging stations were maintained during the whole or part of the season, and 273 measurements of stream volume were made. This work furnishes data in regard to the run-off of about 4,690 square miles. An abstract of the results will be found on pages 201–228, and the complete report is in press as Water-Supply Paper 228.

The great influx of prospectors into the Innoko and lower Yukon region led to a demand for a survey of that district. As funds were not available for a large party, it was decided to make a preliminary examination of the region with a view of determining the general facts with regard to the geology, topography, and distribution of mineral resources. This work was intrusted to A. G. Maddren, who

reached the mouth of the Tanana June 25, and spent about a month in examining the creeks tributary to the Yukon that are reported to be auriferous. He then proceeded to the Innoko and spent the remainder of the season, up to September 25, in this field. His work included the making of a sketch map of the region visited, by means of a rough triangulation and foot traverses. A general knowledge of an area including about 1,000 square miles was thus obtained. An outline of Mr. Maddren's results is contained in this volume (pp. 229–266), and a more complete report is in preparation.

SEWARD PENINSULA.

The geology of Seward Peninsula is exceedingly complex, and though its general features have already been determined and the results published,[a] progress has been but slow in deciphering the details of structure and stratigraphy. These problems have an important bearing on the distribution and occurrence of the mineral deposits, especially of metalliferous lodes.

During 1908 two parties were engaged in detailed stratigraphic studies in this region. One of these, in charge of P. S. Smith, spent the summer in completing the detailed mapping of the Casadepaga quadrangle, in continuing the stratigraphic studies of the Kigluaik Mountains, and in making a reconnaissance across the Bendeleben Mountains. Considerable work was also done in the intermediate areas. As a result the detailed mapping of the Solomon and Casadepaga quadrangles has been completed, and considerable information has been gained which will help to correlate this work with the detailed mapping of the Nome and Grand Central quadrangles. Field work was begun on June 17 and continued until September 26, 90 square miles being mapped in detail and 150 square miles in reconnaissance. The account of the Iron Creek region in this volume (pp. 302–354) is one of the results of this survey, and the detailed geologic report on the Solomon and Casadepaga districts is now in preparation.

The stratigraphy of the northwestern part of the peninsula was the subject of investigations by E. M. Kindle, assisted by R. D. Mesler. Mr. Kindle spent about two months in the York Mountain and Kougarok region, and collected a large number of fossils, which will throw much light on the stratigraphic succession. In connection with this work Mr. Kindle also made a trip to Cape Lisburne and Point Hope for the purpose of establishing stratigraphic correlations.

The investigation of the water resources of Seward Peninsula, so far as they refer to placer mining, was begun in 1906 and continued

[a] Bull. U. S. Geol. Survey Nos. 247 and 328.

through 1907 and 1908. In 1908 the work, in charge of F. F. Henshaw, assisted by A. T. Barrows, was begun June 16 and continued until October 21. Observations were continued at some of the gaging stations in the Nome district and also in those established in the Kougarok district. In addition to this stations were maintained in the Iron Creek district, the upper Casadepaga basin, and the Solomon region. In July Mr. Henshaw extended the work into the Fairhaven district, where observations were continued up to the close of the season. The fact that the season was exceptionally dry makes the results of great value in determining the minimum run-off. These investigations throw light on the available water supply in about 2,000 square miles of the more important placer districts of the peninsula. During the field work 273 measurements of stream volume were made and 21 gaging stations maintained. Mr. Henshaw's results are summarized in this volume (pp. 370–401).

COLLECTION OF STATISTICS.

The work of collecting statistics from the operators, begun three years ago, was continued through 1908. It is gratifying to note that the operators are showing an increased interest in this work, and that most of the large producers are now furnishing the desired information in regard to production. Though the statistical data are by no means yet complete, it is hoped that within another year the figures of production from every important operation may be procured for the purpose of making up totals. During 1908 practically every lode mine in the Territory furnished the statistical data requested. There are still many placer miners who have neglected to reply to the inquiries, which are of necessity sent by mail. It is expected, however, that as soon as these men fully realize the purpose of collecting the data and understand that the individual returns are carefully guarded from the public, they will be willing to cooperate. Those who are not familiar with the methods employed should be informed that the returned schedules are kept under lock and key, and that under no circumstances is anyone allowed access to them except employees engaged in making up the statistical tables. The possibility of revealing information by the publication of data is also carefully avoided. If in a certain district there are only one or two large producers, the total for this district is combined with that for some other district. By these means it is made impossible for anyone to obtain knowledge of the production of any individual mine or property.

So long as the returns from the operators are incomplete it is necessary to obtain the best statistical information available from other sources. This is done by correspondence and personal conference with the better-informed residents of the various districts, the express companies, bankers, and commercial companies. It is gratifying to the writer to be able to state that nearly every person asked for information of this kind has been pleased to furnish it. It should be noted that the Geological Survey is collecting statistics not only of gold, silver, and copper, but also of all other mineral deposits.

PUBLICATIONS ISSUED OR IN PRESS IN 1908.

The publications printed during 1908 have appeared more promptly than those of some previous years. There are still unavoidable delays in the issuing of the more elaborate reports after the manuscript has been completed, yet as a rule the time occupied in publication does not exceed three or four months. One cause of delay in the submission of manuscript is the fact that nearly all the Alaskan publications are of the nature of progress reports, and as every season's field work adds new information there is always a tendency to defer publication until the new data can be incorporated. During 1908 the Survey published seven bulletins, one water-supply paper, and three separate topographic maps relating to Alaska. The complete list is as follows:

REPORTS INCLUDING MAPS.[a]

Geologic reconnaissance of the Matanuska and Talkeetna basins, by Sidney Paige and Adolph Knopf; including geologic and topographic maps. Bull. No. 327.

The gold placers of parts of Seward Peninsula, Alaska, by Arthur J. Collier, Frank L. Hess, Philip S. Smith, and Alfred H. Brooks; including geologic and topographic reconnaissance maps. Bull. No. 328.

Geology and mineral resources of the Controller Bay region, by G. C. Martin; including topographic and geologic maps. Bull. No. 335.

The Fairbanks and Rampart quadrangles, Yukon-Tanana region, Alaska, by L. M. Prindle, with a section on the Rampart placers by F. L. Hess and a paper on the water supply of the Fairbanks region by C. C. Covert; including topographic reconnaissance maps. Bull. No. 337.

Mineral resources of Alaska; report on progress of investigations in 1907, by Alfred H. Brooks and others. Bull. No. 345.

The geology and mineral resources of the Ketchikan and Wrangell mining districts, Alaska, by F. E. and C. W. Wright. Bull. No. 347.

Geology of the Seward Peninsula tin deposits, Alaska, by Adolph Knopf. Bull. No. 358.

Water-supply investigations in Alaska, 1906–1907, by F. F. Henshaw and C. C. Covert. Water-Supply Paper No. 218.

[a] See list of reports in back of this volume.

MAPS ISSUED SEPARATELY.[a]

Controller Bay region special map, scale 1:62,500, contour interval 50 feet. Topography by E. G. Hamilton. Alaska sheet No. 641A.

Berners Bay special map, scale 1:62,500, contour interval 50 feet. Topography by R. B. Oliver. Alaska sheet No. 581B.

Fairbanks special map, scale 1:62,500, contour interval 25 feet. Topography by T. G. Gerdine and R. H. Sargent. Alaska sheet No. 642A.

Map of Alaska, scale 1:5,000,000, or about 80 miles to the inch, compiled under direction of Alfred H. Brooks. Map A.

REPORTS AND MAPS IN PRESS.

Mineral resources of the Kotsina-Chitina region, Alaska, by F. H. Moffit and A. G. Maddren. Bull. No. 374.

The Fortymile quadrangle, Yukon-Tanana region, Alaska, by L. M. Prindle. Bull. No. 375.

The Yakutat Bay region, Alaska: Physiography and glacial geology, by R. S. Tarr; areal geology, by R. S. Tarr and B. S. Butler. Prof. Paper No. 64.

REPORTS AND MAPS IN PREPARATION.

The following papers and maps are in various stages of preparation and will be published as soon as circumstances permit, but probably, for the most part, during the year 1909, provided the funds for printing are sufficient:

Geology and ore deposits of Kasaan Peninsula and Copper Mountain region, Prince of Wales Island, by C. W. Wright; including detailed geologic and topographic maps.

The Yakutat Bay earthquake, September, 1899, by R. S. Tarr and Lawrence Martin.

The Nabesna-White River copper region, by F. H. Moffit and Adolph Knopf; including geologic and topographic reconnaissance maps.

The geology and mineral resources of the Prince William Sound region, by U. S. Grant; including geologic reconnaissance map.

An exploration in the Mount McKinley region, by Alfred H. Brooks and L. M. Prindle; including geologic and topographic reconnaissance maps.

Geology and mineral resources of parts of the Alaska Peninsula, by W. W. Atwood; including geologic and topographic reconnaissance maps.

Geology and mineral resources of the Fairbanks district, by L. M. Prindle and F. J. Katz; including detailed geologic map.

Water-supply investigations in Fairbanks, Hot Springs, Rampart, and Birch Creek districts, by C. C. Covert and C. E. Ellsworth. Water-Supply Paper 228.

A reconnaissance of the Innoko and lower Yukon placer districts, by A. G. Maddren.

Geology of the Nome and Grand Central quadrangles, Alaska, by F. H. Hess, F. L. Hess, and P. S. Smith; including detailed geologic map.

Geology of the Solomon and Casadepaga quadrangles, by P. S. Smith and F. J. Katz; including detailed geologic map.

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[a] Sale publications. See list in back of this volume.

Fairbanks quadrangle map, scale 1:250,000, contour interval 200 feet. Topography by T. G. Gerdine, D. C. Witherspoon, and R. B. Oliver.

Circle quadrangle map, scale 1:250,000. Topography by D. C. Witherspoon.

Rampart quadrangle map, scale 1:250,000, contour interval 200 feet. Topography by D. C. Witherspoon and R. B. Oliver.

Nizina special map, Copper River region, scale 1:62,500, contour interval 100 feet. Topography by D. C. Witherspoon.

THE MINING INDUSTRY IN 1908.

By ALFRED H. BROOKS.

INTRODUCTION.

Measured either in terms of production or in amount of dead work accomplished or planned, the mining industry of Alaska during 1908 not only did not progress as much as was expected but in some ways showed a distinct decline as compared with the previous year. This retrogression might discourage the mine operator were it not due in part to the widespread business stagnation which followed the financial panic and in part to certain conditions which are not unchangeable.

Though the gold placer mines already on a productive basis were not materially affected by the business depression, many of those requiring capital for extensive plants made but little headway. A more serious matter to the placer miner was the drought which prevailed throughout the summer months in nearly all the important districts. The lack of water so curtailed the output of all the Yukon and Seward Peninsula districts that the value of the total output of placer gold from these sources was probably nearly a million dollars less than in 1907. This decrease of the placer-gold production for Alaska as a whole is, however, but temporary, for the maximum annual output of the auriferous gravels has not yet been reached. In spite of the business depression the production of the auriferous lode mines of the Territory in 1908 was about 22 per cent greater than in 1907.[a] On the other hand, the fall in the price of copper from an average of 20 cents for 1907 to 13.2 cents in 1908 led both to a decrease in the output of that metal and to a diminution of the preparations for its future mining. However, the fact that a number of mines continued to ship ore in spite of its low market value indicates the permanency of the copper-mining industry of the Territory.

Among the conditions that are retarding the advancement of the mineral industry are the inadequacy of the public-land laws under which placer ground is acquired and held and the delays in obtain-

[a] The exact figures for mineral production of the Territory are not available at this writing.

ing title to coal lands. In spite of these and other adverse conditions, which will be discussed in another place (see p. 36), the value of the total mineral production for 1908 is $19,929,800. The sources of this wealth, as well as a comparison with the previous year, are presented in the following table of production:

Mineral production of Alaska, 1907–8.

	1907.		1908.[a]		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....ounces..	936,043.81	$19,349,743	923,962.50	$19,100,000	− 12,081.31	−$249,743
Silver.....do....	149,784	98,857	140,000	74,200	− 9,784	− 24,657
Copper.....pounds..	6,308,786	1,201,757	5,050,000	666,600	−1,258,786	− 595,157
Tin.....	.....	20,000	.....	.....	.....	− 20,000
Coal.....short tons..	10,139	53,600	4,000	19,000	− 6,139	− 34,600
Marble, gypsum, and mineral water.....	.....	63,098	.....	70,000	.....	+ 6,902
	.....	20,887,055	.....	19,929,800	.....	− 917,255

[a] Preliminary estimates.

NOTE.—In the above table copper is valued at 20 cents a pound for 1907 and at 13.2 cents for 1908; silver at 66 cents an ounce for 1907 and at 53 cents for 1908.

It will be noted that over half of the decrease in the value of the total mineral production is due to the lesser output of copper, which is directly chargeable to the fall in the market value of that metal. This table does not, however, indicate the very marked decline of the placer-gold output, to which reference has already been made and which will be discussed elsewhere. (See p. 31.) The decrease in coal production is not significant, for the coal-mining industry has not yet become established and the present output is from only a few mines. Tin mining was practically suspended during 1908, though a few tons of concentrates were shipped. In the above table the value assigned to the marble and gypsum production is that of the raw material. The figures for these products are not separated, for as there is only one large marble company and one gypsum company such a separation would reveal the output of the individual producers.

Value of total mineral production of Alaska, 1880–1908.

By years.				By substances.	
1880–1890.....	$4,686,714	1901.....	$7,007,398	Gold.....	$142,030,637
1891.....	916,920	1902.....	8,400,693	Silver (commercial value).....	1,120,562
1892.....	1,096,000	1903.....	8,941,614	Copper.....	4,265,136
1893.....	1,048,570	1904.....	9,567,535	Tin.....	92,640
1894.....	1,305,257	1905.....	16,478,142	Coal.....	315,079
1895.....	2,386,722	1906.....	23,375,008	Marble and gypsum:.....	148,647
1896.....	2,980,087	1907.....	20,887,055		
1897.....	2,538,241	1908.....[a]	19,929,800		147,972,701
1898.....	2,585,575				
1899.....	5,703,076		147,972,701		
1900.....	8,238,294				

[a] Preliminary estimate.

The increased gold production from the auriferous lodes came largely from the Juneau district, where some notable advancements were made. In the Ketchikan district one new copper deposit was opened, and one mine continued operations throughout the year, several others making shipments of copper ore during a part of the year. In the coal fields of Controller Bay and the Matanuska assessment work and surveys for patents constituted the bulk of the activities. Considering the discouraging condition of the copper market, there was much systematic prospecting in the copper-bearing belts of Copper River and in the Prince William Sound region. In the latter district one mine was in operation throughout the year and several others made small shipments. The construction of a railway up Copper River, which was one of the most important events of the year for the mineral industry, is referred to under the next heading. Considerable attention was paid to the lodes of the Kenai Peninsula, Kodiak Island, and southwestern Alaska, and one mine in the last-named district was in operation. There was much activity in the placer districts of the Susitna basin, including Yentna River and Valdez Creek, but it was confined chiefly to small operators. Two auriferous lodes are being opened on a small scale in this field.

Of the placer districts Fairbanks was the most prosperous, but here, as well as in other parts of the Yukon basin and in Seward Peninsula, the drought during the summer months much curtailed production. No discoveries of auriferous gravels have been reported for 1908, though the productive areas in several of the districts have been increased.

TRANSPORTATION.

The full development of the mineral wealth of inland Alaska must await improvements in means of communication, which will need to be of a very radical character. The expensive and uncertain mode of reaching the Yukon placer districts by ocean and river boats or long winter sled journeys places so heavy a tax on the gold-mining industry as to make it in most places impossible to exploit anything but the richest placers. The copper deposits of Copper River and the coal fields of Controller Bay and the Matanuska basin must remain unproductive until a transportation system has been developed.

Thanks to the Alaska road commission, and in a lesser degree to local enterprise, much has been accomplished in the way of road and trail building. Much, however, remains to be done, for in this Territory, embracing nearly 600,000 square miles, there are only 452 miles of wagon road, 397 of sled road, and 255 of trail.[a] The coastal service of ocean vessels and the river transportation systems of the Yukon and its tributaries are being much improved. In addition to this,

[a] Ann. Rept. Secretary of War, 1908, p. 97. Unimproved trails are not included in this mileage.

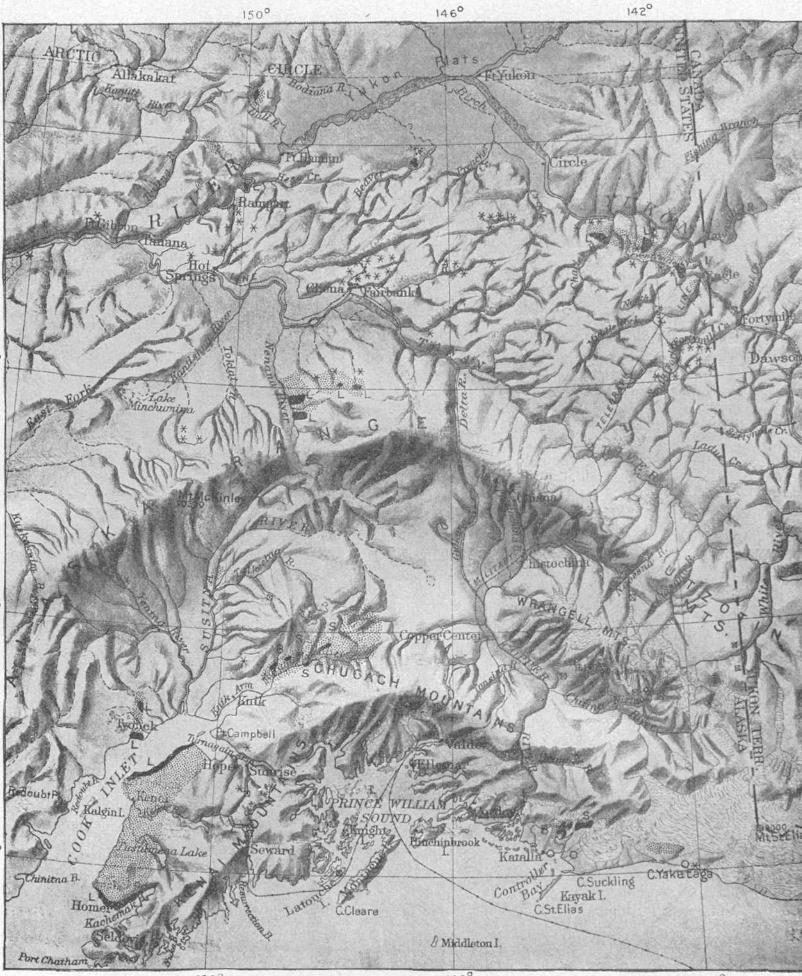
steamboats have been placed on Copper and Susitna rivers. Local transportation facilities have also been greatly bettered by short lines of railway, such as those at the White Pass, at Fairbanks, and in Seward Peninsula. All these improvements in means of communication, together with the military telegraph lines, wireless stations, and long-distance telephone systems, have done much to advance the mining industry. They can, however, be regarded only as supplementary to a system of railways, which alone can make available the mineral wealth of extensive areas. In fact, they serve to emphasize the inadequacy of the existing transportation systems. The industrial demands for better communication can be met only by railways which shall connect the mineral deposits with open ports on the Pacific seaboard. The writer has discussed the matter of railway location at some length elsewhere,[a] but the matter seems to justify a restatement of some of the salient features of the problem.

The known mineral wealth of inland Alaska is embraced in the two copper-bearing belts of Copper River, lying 100 to 300 miles from tide water; the Bering River coal field, 25 miles from the coast at Controller Bay and 100 miles from a good harbor on Prince William Sound; the Matanuska coal field, 150 miles from an ice-free port on the Pacific; and the Yukon placers, from 400 to 600 miles by feasible railway routes from the Pacific. This inland region is separated from the Pacific tide water by high snow-covered ranges, broken, however, by several river valleys. (See Pl. I.)

There are three possible routes of approach to these mining fields. One leaves the coast at Lynn Canal and, crossing by a broad gap from the Chilkat to the Alsek basin, finds there an easy route for railway construction along the inland front of the St. Elias Range to the head of the Tanana Valley, and thence into the heart of the placer fields. Though such a railway would reach only one of the copper belts and would not help to develop the coal fields, it would traverse the Territory from southeast to northwest and make accessible a large area.

A second route is via the Copper River valley to the Kotsina-Chitina copper belt. A railway following this route is under construction; it can reach the Bering River coal field by a branch line and can be extended to the placer districts of the Yukon basin through a pass that connects the Delta and Copper basins, reaching by a branch line the Nabesna-White copper-bearing area. There is a choice of coastal terminals for this route—either Valdez Inlet, Orca Bay, or Katalla. Each has some advantages, but after careful surveys and investigations Orca Bay, with a terminal at the town of

[a] Brooks, Alfred H., Railway routes: Bull. U. S. Geol. Survey No. 284, 1906, pp. 10-17; Railway routes in Alaska: Nat Geog. Mag., March, 1907, pp. 164-190.



LEGEND

⁎ Gold placers	Areas known to contain workable coals
× Gold and silver lode mines and prospects	S Anthracite, semianthracite, and semibituminous, including the better coking coals
⊠ Copper mines and prospects	B Bituminous and subbituminous coals
Coal-bearing rocks	L Lignite
	O Petroleum seepages

50 0 50 100 150 200 miles

50 0 50 100 150 200 kilometers

RELIEF MAP OF CENTRAL ALASKA, SHOWING DISTRIBUTION OF MINERAL RESOURCES.

Cordova, has been chosen by the line under construction. It is currently reported, however, that other projects for railway construction from Valdez and Katalla have not been abandoned.

The third possible route is from Resurrection Bay across a low pass to Turnagain Arm, thence up the Susitna Valley and across another pass to the Nenana. This railway would serve the placer district of the Kenai Peninsula and the Susitna basin, but, what is more important from the standpoint of developed tonnage, would tap the Matanuska coal field. A railway now under construction over this route has its coastal terminal at the town of Seward, on Resurrection Bay. (See Pl. I.)

The following table presents the available data regarding the railways of the Territory:

Mileage and terminals of Alaska railways, December 4, 1908.

	Miles.
Southeastern Alaska:	
White Pass and Yukon Railroad, Skagway to White Pass (narrow gage)....	20.4
(Terminal at White Horse, Yukon Territory. Total mileage, 102 miles.)	
Yakutat Southern Railway, Yakutat to Situk River (narrow gage).....	9±
Copper River:	
Copper River Railroad, Cordova to Childs Glacier (September 17) (standard gage).....	47
(Probably 11 miles have been built since September 17. The same company has built a few miles of track at Katalla, where the Alaska Pacific Railway and Terminal Company has also done some work. At Valdez, a few miles of track of the Alaska Home Railway were laid in 1907, and some work was previously done on the Copper River and Northwestern Railway.)	
Kenai Peninsula:	
Alaska Central Railroad, Seward to a point near head of Turnagain Arm (standard gage).....	53
Yukon basin:	
Tanana Valley Railroad, Fairbanks and Chena to Chatanika (narrow gage).	46
Seward Peninsula:	
Seward Peninsula Railway, Nome to Shelton (narrow gage).....	80
Paystreak branch Seward Peninsula Railway (narrow gage).....	6.5
Council City and Solomon River Railroad, Council to Penelope Creek (standard gage).....	32.5
Wild Goose Railway, Council to Ophir Creek (narrow gage).....	5

Portions of the Council City and Solomon River and the Alaska Central railroads are out of repair and not in use.

From all accounts the various projects for railway construction from Katalla and Valdez were dormant during 1908. In contrast to these is the activity of the Copper River Railway Company, which laid about 50 miles of track during the year. The same corporation is also extending its steamboat service on lower Copper and Chitina rivers, so that it is probable that in 1909 the Chitina-Kotsina copper

belt may be reached by railway and steamers and thus the long overland journey now necessary may be avoided. Surveys have been made and some work done by the Katalla and Carbon Mountain Railway Company on a project to build a line from Controller Bay directly to the coal field across the broad flat of Bering River. The distance will be about 25 miles.

During 1908 but little construction work was done on the Alaska Central Railroad, which went into the hands of a receiver in the summer. A reorganization of the company is reported to be under way. A feature of importance to the transportation problem in this region is the improvement of the steamboat service on the Susitna, now planned for 1909.

METAL MINING.

INTRODUCTION.

In spite of the decrease of the placer production and the increase of the auriferous lode production in 1908 as compared with 1907, the placers yielded over four-fifths of the value of the precious-metal output. As complete statistical returns are not yet available, it is impossible to give exact figures in regard to the sources of the metal production for 1908. The following table, however, is believed to be less than 10 per cent in error and will serve to show the relative importance of the various sources of the gold, silver, and copper.

Sources of gold, silver, and copper in Alaska, 1908, by kinds of ore.[a]

	Gold.		Silver.		Copper.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.	Quantity (pounds).	Value.
Silicious ores	172,553.63	$3,567,000	28,000	$14,840	.....	.....
Copper ores	3,773.25	78,000	42,000	22,260	5,050,000	$666,600
Placers	747,635.62	15,455,000	70,000	37,100	.....	.....
	923,962.50	19,100,000	140,000	74,200	5,050,000	666,600

[a] This table is based on preliminary estimates, before complete statistical returns are available.

The growing importance of the metal-mining industry is shown in the following table, which exhibits the total production of gold, silver, and copper since mining first began, twenty-eight years ago. The figures for years previous to 1905 are not very reliable, as it is only since that year that an attempt has been made to collect statistics of production from individual operators—the only source of exact information regarding output.

Production of gold, silver, and copper in Alaska, 1880–1908.

Year.	Gold.		Silver.		Copper.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.
1880	968	$20,000			3,933	$826
1881	1,935	40,000			.....	.....
1882	7,256	150,000			.....	.....
1883	14,566	301,000			.....	.....
1884	9,728	201,000	10,320	$11,146	.....	.....
1885	14,513	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	61,927	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	536,101	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	1,201,757
1908	923,962	19,100,000	140,000	74,200	5,050,000	666,600
	6,632,885	142,035,237	1,817,159	1,120,562	25,893,352	4,265,136

NOTE.—Gold and silver production for 1880-1904 based on estimates of Director of Mint; for 1908, preliminary estimate. Silver values are average commercial values for year and not coinage value. Copper production for 1880 from Tenth Census (vol. 15, p. 800); for 1900-1904, estimated; for 1908, preliminary estimate. Copper values are based on averages for year.

In the following table the total gold production is distributed according to districts, so far as the information at hand will permit. The error in distribution is believed to be less than 10 per cent, and it is hoped in the future to eliminate it altogether. (See p. 17.) The production from the Pacific coast belt is, for the most part, from the lode mines of southeastern Alaska, but includes also a small placer output, as well as the production from a lode mine on Unga Island. The gold credited to the Cook Inlet and Copper River region is, aside from the output of two small quartz mines, all from placers, and includes the yield of the Nizina, Chistochina, and Sunrise districts and of the productive creeks of the Susitna basin.

The gold output from Seward Peninsula and the Yukon basin[a] is nearly all from placers, though there was a small production from some lode prospects in Seward Peninsula.

[a] This refers, of course, only to the Alaskan part of the Yukon basin, and does not include the production of the Klondike and other Canadian camps.

Value of gold production of Alaska, with approximate distribution, 1880–1908.

Year.	Pacific coast belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula.	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	833,000		200,000		1,033,000
1894	882,000		400,000		1,282,000
1895	1,569,500	$50,000	709,000		2,328,500
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	3,195,800	500,000	1,300,000	4,164,600	9,160,400
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[a]	3,410,000	400,000	10,190,000	5,100,000	19,100,000
	43,721,937	3,742,000	45,204,000	49,362,700	142,030,637

[a] Preliminary estimate.

LODES.

The first auriferous lode known in Alaska was discovered near Sitka in 1877, but the first important production of gold was from the Treadwell mine in 1882.[a] From 1882 to 1908 the auriferous lodes have produced about 1,958,000 fine ounces of gold, valued at $40,573,000, and 934,434 fine ounces of silver, valued at $576,500. The first attempt at copper mining was made in 1881, when a few thousand pounds of this metal were produced from deposits on Prince of Wales Island. Systematic development of copper deposits began on Prince William Sound in 1900 and on Prince of Wales Island in 1905. Of the total copper production up to the close of 1908, amounting to 25,893,352 pounds, 16,160,619 pounds came from the Prince of Wales Island mines and the remainder from those of Prince William Sound.

The search for lode tin deposits began in 1902, since which time some small shipments of tin ore have been made. However, most of the tin output has come from the placers. Antimony, tungsten, galena, and other ores have been found, but so far the production has been insignificant.

Iron ores (magnetite) are known to occur in southeastern Alaska, where they have been somewhat prospected, as well as on Prince Wil-

[a] Some shipments of galena ore were made from the Omalik mine on Seward Peninsula in 1881.

liam Sound and at other localities. There has, however, been no iron-ore production.

During 1908 auriferous-lode mining made considerable advances, both in production and in the discovery of new ore bodies of possible commercial importance. The copper-mining industry was less prosperous as regards production and dead work accomplished; but, on the other hand, probably more systematic prospecting of copper lodes was carried on than in previous years. Though there was some prospecting of tin, tungsten, antimony, and other kinds of ore bodies than those above noted, there was no production from them and relatively little was accomplished in proving the presence of commercially valuable amounts of ore. Worthy of note is the discovery of a small vein of wolframite (tungsten ore) on Deadwood Creek, in the Circle precinct. Though not known to be of commercial importance, this is at least a new locality for tungsten ore.

Twelve gold and silver lode mines were on a productive basis in 1908, as compared with thirteen in 1907. The increase in the output of the auriferous lodes all came from the Treadwell group and other mines of the Juneau district. The tonnage of the auriferous-lode mines of Alaska for 1908 is estimated at 1,700,000 short tons, as compared with 1,209,639 tons in 1907. The average values of the siliceous ores for 1908 can not be computed until complete statistical returns are at hand. In 1907 the average gold and silver values for all the siliceous ore hoisted was $2.30 a ton; for the siliceous ores other than those of the Treadwell group, $3.41 a ton. It will be evident, therefore, that the productive auriferous-ore bodies of Alaska are of a low grade.

Nine copper mines made some shipments of ore in 1908, as compared with thirteen in 1907. The total tonnage of the copper mines in 1908 is estimated at 50,000 short tons, compared with 98,927 tons in 1907. Complete statistics being lacking, it is impossible to give the average metal content of the copper ore. In 1907 the average of all the copper ore mined in Alaska carried $1.30 a ton in gold and silver and 3.18 per cent of copper. It is probable that the copper percentage of the ore mined in 1908 was somewhat higher than that mined in 1907, because, owing to the low price of copper, only the richer ores could be mined at a profit.

All the important lode-mining districts are covered by special reports in this volume, so that they need not be discussed here. Among the features of these reports having special significance is the auriferous lode on Prince William Sound, described by Mr. Grant (pp. 87–97), and the finding of gold values in an ore body in the Fairbanks district, described by Messrs. Prindle and Katz (pp. 181–200). Mr. Atwood's report (pp. 148–152) also indicates the probability of the

occurrence of commercial ore bodies in southwestern Alaska in addition to those already productive.

Mr. Grant has described some gold and copper prospects in the vicinity of Seward, on the Kenai Peninsula (p. 98). In addition to these there are other localities where ore bodies are reported. Through the courtesy of Dr. H. O. Sommer, of the United States Coast and Geodetic Survey, the writer received a sample of pyritiferous quartz from Port Dick which carried 0.123 ounce of gold and 1.32 ounces of silver to the ton. This shows a total value of $3.24 a ton for the ore, a value which, considering the fact that the locality is near a harbor that is open throughout the year, is not prohibitively low. No data are at hand in regard to the dimensions and occurrence of the ore body. There is said to be considerable prospecting in this district.

The extension of the Kenai Peninsula belt of metamorphic rocks is to be sought on Kodiak Island, where, indeed, they have been recognized, though but little geologic work has been done. Placer gold has been found at a number of widely distributed localities in the beach deposits of the island, indicating that the bed rock is auriferous. According to Charles W. Fletcher, auriferous beaches have been found at Uyak and Uganik bays, at Red River, at Sevenmile Beach, near Kaguyak, and at several places on Afognak Island, lying north of and adjacent to Kodiak Island. One small gold mine was in operation for a number of years on Uyak Bay, but operations appear to be suspended. Mr. Fletcher also reports the occurrence of copper in the vicinity of Womens Bay, Kodiak Island. In view of the accessibility of Kodiak Island, mining costs should not be great, and further prospecting would appear to be justified.

Considerable activity has recently been shown in prospecting for auriferous quartz on Little Willow Creek, a tributary of lower Susitna River. Here a 3-stamp mill was installed in 1908 and a 5-stamp mill was taken in, though its erection was not completed. Mr. Atwood reports that he saw some specimens of quartz from this district which carried a large amount of free gold. There is no information at hand regarding either the occurrence of the ore bodies or their dimensions. Discoveries of copper and gold bearing veins in other parts of the Susitna basin are also reported, but no further information concerning them is available.

There is an increasing interest in lode prospecting throughout the Yukon placer districts,[a] yet but little work has been done toward proving any particular locality. The finding of a wolframite-bearing vein in the Birch Creek district and of stibnite and gold ores in the Fairbanks region has already been referred to. According to S. J. Marsh some promising auriferous quartz veins have been found on Big Creek, in the Chandalar precinct. These veins are said to occur

[a] As this volume goes to press some very encouraging reports have been received from the development of lodes near Fairbanks.

in mica schist near intrusives of porphyry and to carry high values in free gold. Gold-bearing veins are also reported from the Koyukuk district, but no information is available in regard to them. The writer has received some pyritiferous vein quartz from C. K. Snow, said to have come from the Koyukuk, one piece of which on assay yielded a value of $1.94 in gold with a trace of silver, while the others showed only a trace of gold.

For several years the Kuskokwim Basin has attracted many prospectors who have found some placer gold, but more commonly report promising auriferous veins. The region is so difficult of access that apparently but little attempt has been made to do sufficient work on any of these ore bodies to prove their commercial value. Attention has also been directed to some occurrences of cinnabar, long known on the lower Kuskokwim.

The writer was fortunate in meeting C. Betch, of the Russian mission on Yukon River, who has spent several years in prospecting for lodes in a region lying southeast of the lower Kuskokwim Valley. Mr. Betch describes this region as including some high mountains, with a dominating country rock, where ores have been found, of limestone intruded by granites. The ore bodies are said to be well defined. Specimens collected by Mr. Betch show molybdenite, pyrite, mispickel, and realgar in a matrix which is chiefly quartz. These ores are said to carry gold values.

Placer gold has been known since 1898 to occur on Kobuk River, and during the last five years there has been a small annual production. According to the statement of Lewis Lloyd, of Shungnak, there have been some promising discoveries of metalliferous lodes in the upper Kobuk Valley and the adjacent parts of the Noatak River basin. Mr. Lloyd reports the presence of copper, galena, and free-milling gold ores in this district. One body of chalcopyrite and bornite ore has been opened near the head of Cosmos Creek by a tunnel 70 feet deep. Picked samples of this ore are said to have yielded about $2 in gold and silver and 28 to 58 per cent in copper. Assays of other ores from this district show a copper content of 5 to 11 per cent. Of importance also is the report by Mr. Lloyd of native copper nuggets in the gold placers of this region. This region is a new field for the occurrence of metalliferous lodes, and for this reason the data have been given in more detail than is customary where they are not collected by members of the Survey.

GOLD PLACERS.

INTRODUCTION.

The placer-gold production of Alaska for 1908 is estimated at $15,455,000 in value, as compared with $16,491,000 in 1907. Nearly two-thirds of this output was from the Yukon basin, a little less

than one-third from Seward Peninsula, and the remainder from the widely distributed smaller districts. The output of winter mining for the entire Territory was a little less than half of the total. During the summer of 1908 about 770 placer mines were on a productive basis, but probably less than half of these were operated throughout the open season. The data in regard to the number of placer-mine operations in previous years are very incomplete, but it is believed that the number of mines operated in the summer of 1908 was about 10 per cent less than the number operated during the summer of 1907. There is little information at hand in regard to the number of mines worked during the winter of 1907–8, but it was probably less than 500.

The best information available indicates that there were about 4,400 men engaged in productive placer mining throughout Alaska during the summer of 1908 and about 3,400 during the previous winter. In addition to these, at least 2,000 men were employed during the summer in prospecting, installing plants, and other dead work relating to the placer-mining industry. The winter work of this character employed probably less than half as many. The summer population of all the placer-bearing regions of Alaska is estimated at 28,000 and the winter population at 17,000. The above estimates, which are believed to be conservative, though not very reliable, admit of some suggestive comparisons. In using these figures it should be stated that, while they are only approximations, the error in them is probably not sufficient to seriously impair the value of the deductions to be presented.

The value of the average production of gold per placer mine for the whole of Alaska during the summer of 1908 was about $10,000. In the smaller Yukon districts the average was from $4,000 to $7,000; the Fairbanks mines averaged an output of somewhat over $12,000 and those of Seward Peninsula over $16,000. These figures indicate that in the last-named region the operations were conducted on a larger scale. The average output of gold per placer miner engaged in productive work in the whole of Alaska during the summer of 1908 was about $1,700, that for Fairbanks averaging $1,900, and for Seward Peninsula $2,300. If, however, the men engaged in prospecting and dead work are included, as well as the miners, the average production for all Alaska is $1,200, for Fairbanks $1,600, and for Seward Peninsula, $1,400. The higher average per capita production at Fairbanks, compared with Alaska as a whole, is probably due largely to the richness of the gravels exploited rather than to the magnitude of single operations. On the other hand, the large output per miner in Seward Peninsula is due to the facts that there many labor-saving devices are in use, and that during 1908 most of the small plants were closed because of lack of water.

It is evident that the output per man of a single well-managed successful dredge will be enormous as compared with that of an ordinary pick and shovel plant. These estimates of production per miner certainly appear very large, but they are less encouraging when the very high cost of living is considered. It should also be remembered that the bona fide miners and prospectors constitute hardly 25 per cent of the population, which is practically supported entirely by the placer-mining industry of the gold-producing regions. On the basis of the estimates of population presented, the per capita production of Alaska is determined to be only $270 for the open summer season and $690 for the entire year. On Seward Peninsula the per capita production is $210 for the summer and $640 for the entire year. This low per capita production is to be accounted for by the fact that the population was determined by the successful results of the previous year. On the other hand, the Fairbanks summer output per capita is estimated at $590, whereas the annual output per capita is over $1,100. In considering these figures it should be remembered that subsistence, fuel, etc., cost from $500 to $800 per man annually in most of the Alaska placer camps. The cost of subsistence is somewhat less in proportion during the open season, but the cost of traveling to and from Alaska, which averages from $100 to $300, must be included in the estimate for those who do not remain during the winter.

It has already been stated that, considering Alaska as a whole, the decrease in the value of the placer-gold output is chargeable for the most part to the dry-weather conditions which prevailed throughout the open season in both the Yukon and the Seward Peninsula districts. It is unquestionably true that had there not been a shortage of water for sluicing, the output for 1908 would have exceeded that of 1907. Nevertheless, it can not be denied that even if the season had been favorable the approaching exhaustion of some of the bonanzas, such as the "third beach line" at Nome and some of the older producing creeks at Fairbanks, would have seriously reduced the production were there not other rich deposits which would have been mined had the water conditions permitted. In other words, the maintenance of the present high placer-gold production is dependent in large measure on the discovery of other bonanzas of equal richness to those which have been exploited. This does not signify that a large production is not to be expected from the gravels of low gold tenor, but simply that relatively but little has been accomplished in preparing to exploit these deposits. Therefore, unless some new important finds are made, it will not be many years before the placer output must decrease unless the methods of exploitation are revolutionized. By this statement it is not intended to imply that the

auriferous gravels of either the Yukon or Seward Peninsula are even approaching exhaustion, for the low-grade material is almost untouched, but it is intended to point out that the time is not far distant when the inevitable necessity of reduction in cost of operating must be faced.

The discovery of new rich deposits does not change the problem, but simply defers its solution. All placer districts must pass through this period of evolution, and the sooner the fact is recognized the easier becomes the transition from the bonanza camp, with its constant business fluctuations, to the one where the exploitation of large bodies of lower-grade material gives a lasting prosperity. It is unfortunate to delay this transition until all the rich gravels are mined out. Such a policy (and the Klondike is an excellent example of a locality where it has been followed) leads to a long period of business stagnation before the establishment of the new mining enterprises revives activity.

It is only natural that the first comers to a new placer region should devote themselves to the exploitation of the bonanzas in the auriferous gravel, for these give promise of quick and large returns on a relatively small outlay of capital and time. Bonanza mining, however, though it attracts a large population and brings about the rapid opening of a new region, does not make for a permanent mining industry. Usually a large percentage of the operators attracted by this exploitation of bonanza placers have neither the experience, the capital, nor the patience necessary for the economic exploitation of large gravel bodies carrying lower values. Even where the bonanza miner has the technical skill and capital, he is only too often made careless by the expensive methods employed in mining the very rich gravel beds. The pioneer miners, therefore, who must be credited with the discovery and opening of new districts, often take but little part in the development of large enterprises.

In both Seward Peninsula and the Yukon districts bonanza operators still predominate among the mining population. As a result, with some notable exceptions, there has been but little progress in the improvement of mining methods. Though considerable capital has been brought into Seward Peninsula, much of it has been expended on ill-advised or mismanaged schemes. Many of these enterprises have failed because of the lack of proper technical supervision. To prove this it is only necessary to cite the miles and miles of expensive ditches built on Seward Peninsula, the money on which has been utterly wasted, because no proper measurement of the water was made before their installation.

The effect of bonanza mining is well illustrated by the changes brought about through the discovery of the "third beach line" at Nome in 1905. At that time many of the miners were becoming

attracted to the working of some of the lower-grade gravels in various parts of the peninsula. The finding of this fabulously rich beach line, however, led to the centering of all interests on its exploitation. Much of the best technical talent and capital available for mining was expended in exploiting this beach line or in searching for other similar deposits. As a result there was a retardation, or even a retrogression, in the development of other phases of the mining industry. Although there is no case exactly comparable to this in the Yukon district, yet the rich creek placers found near Fairbanks led to the neglect of enterprises looking to the exploitation of the extensive gravel deposits carrying lower values. It is gratifying to note, however, that during the past season there was a marked increase of activity in both Seward Peninsula and the Yukon districts in making preparations to mine deposits of this type.

Though new bonanzas will undoubtedly be discovered and new eras of prosperity be inaugurated thereby, there can be no doubt that the future advancement of the placer-mining industry in both the Seward Peninsula and the Yukon camps will depend mainly on an improvement in mining methods and a reduction in costs, which will enable the operator to profitably exploit the lower-grade gravels. The term low grade is, of course, only relative and is not intended to include all deposits carrying values that might be profitably exploited in the States. It is probably true that at present there is little placer mining done in Alaska on ground which averages less than $2 to the cubic yard, and that much the larger part of that now mined carries values exceeding $3 or $4 to the cubic yard. These figures are only approximate, because there are but few operators who have any definite knowledge of the values contained in the ground they are exploiting. At Fairbanks it is generally conceded that ground that runs less than a dollar to the square foot of bed rock can not be mined at a profit. This ratio, interpreted in figures more familiar to the average mining man, indicates values of about $3.50 to $4 to the cubic yard. (See p. 199.) The cost of deep mining in Seward Peninsula is probably somewhat less than at Fairbanks, because of the lower freight rates. In Seward Peninsula, moreover, there are many mining enterprises (such as dredging, hydraulicking, and probably also some open-cut mining) where the cost of operation is far less than $2 to the yard. The above figures, though only rough approximations, will serve to indicate at least how high operating costs are in Alaska as compared with those in the States.

Evidently there is a large field here for the introduction of improved mining methods, but it is not so easy to forecast the direction these improvements will take. This is, in fact, a problem for the mining engineer and should be treated by him. As a rule each property will have to be carefully studied by a competent engineer to deter-

mine the best methods of exploitation. It is undoubtedly true that the lack of experienced engineers in this northern field has been responsible for the many failures which have been made in placer mining. The pioneer is too prone to believe himself fully capable of solving any problem that he may meet and is usually very ready to experiment in spite of the high cost of such a procedure.

MINING CONDITIONS.

In last year's report Mr. Hutchins [a] discussed at some length the factors which control placer mining and dwelt on those conditions which are peculiar to Alaska. It will not be necessary to repeat here what he has already said; for the purposes of this discussion, however, certain conditions will be considered, but without attempting to cover the entire field. This again is evidently a problem for the engineer and not the geologist.

Analysis of the conditions affecting placer mining in Seward Peninsula and the Yukon districts shows one dominating feature common to both regions—the inadequacy of the water supply at a sufficient altitude for use under gravity. It appears that this fact has not always been recognized by those engaged in placer mining. The misconceptions prevalent in regard to the available water supply at Nome are probably due to the fact that the rainfall during the first few years of mining happened to be abnormally large. Unfortunately the records of the last decade, incomplete though they are, all point to the conclusion that seasons of low precipitation are normal and seasons of high precipitation abnormal. (See pp. 223 and 397.)

In the Yukon region the precipitation is better known, though actual records here also are exceedingly meager. The pioneer miners in this region required only a relatively small amount of water, and hence the scantiness of the supply available was not forced on their attention. So long as operations were confined to the sluicing of a few claims in a drainage basin, the water supply being adequate, the semiarid climatic conditions were not always recognized. When, however, a large number of operators began utilizing the water on any one creek, it soon became evident that the water supply was inadequate. This of course applies only to the dry seasons, for during wet seasons there is usually ample water for mining operations, though even then it is often only the larger creeks that will furnish a supply sufficient for hydraulic mining. The rainfall records of the Yukon district, so far as they are understood, seem to indicate that the rainfall is exceedingly local and that probably the total precipitation for the year does not exceed 10 to 18 inches. (See p. 223.)

[a] Hutchins, J. P., Prospecting and mining gold placers in Alaska: Bull. U. S. Geol. Survey No. 345, 1908, pp. 64–77.

The general topographic condition has an important bearing on the question of water supply. The absence of high mountain ranges, which would be the centers of snow accumulation during the winter and the loci of more abundant precipitation, is characteristic in the placer districts of both provinces. In Seward Peninsula there are several mountain masses where the precipitation is considerable. (See p. 397.) The most prominent of these ranges are the Kigluaik and Bendeleben Mountains, which form the most important source of water supply of the peninsula. Though some of the mountains in the Yukon basin are equally high, most of them are rounded domes and lie far below the altitude of permanent snow. The only exception is the Alaska Range, which bounds the Yukon basin on the south. The streams that have their sources in this range are fed in part by glaciers and in part by perpetual snow fields and furnish abundant water supply. This water has not been utilized, because no considerable placer mining for which it would be available has been done.

The relief and the character of the river valleys also affect the conditions of placer mining. In both Seward Peninsula and the Yukon basin the streams are characterized by very low gradients, and this is also true in most places of the bed-rock floors under the alluvium. These low gradients necessarily have an effect on the cost of mining, because they increase the difficulties in the disposal of tailings and decrease the cutting power of the water used for hydraulic purposes.

Undoubtedly the heaviest item of expense in all Alaskan placer-mining operations is that of transportation. This affects not only the cost of the initial installation of the plant, but also operating expenses, including labor and fuel. It is difficult to make any generalization as to the cost of transportation to the various placer districts. The freight rates to the various camps are easily obtained, but these rates usually represent only a small fraction of the cost of the transportation to the mines. Thus the freight rate to Nome is about $15 a ton, but it often costs several times this rate to move the supplies from Nome to the scene of mining operations. Again, the cost of shipment of freight to the various camps on the Yukon is about $75 to $110 a ton, but after the steamer has delivered the supplies on the bank of the river the heaviest cost of transportation often begins, for the amount paid for transshipping the supplies from the steamboat landing to the mines varies from $60 to several hundred dollars a ton, even under the best conditions.

The high cost of transportation also affects the cost of labor. A laborer may be taken to Nome during the summer months for $30 to $40, yet he can not be landed there until several weeks after the open season has begun. Transportation for a laborer to Fairbanks costs

about $100, but whereas the mining season begins in the latter part of April, steamboat communication with the outside world is not to be had until the middle of June. Moreover, though the mining season may last through October, the last passengers for the outside by steamer usually leave Fairbanks by September 20. Hence, to utilize the services of a man during the entire mining season in either Seward Peninsula or the Yukon district, it is necessary to employ him throughout the year or to send him both in and out of the country by long and expensive journeys over the snow. Therefore, if the wages of $5 or $6 a day appear to be high, it must be remembered that the working season is short and the laborer at a very large expense for getting into and out of the country. At Fairbanks and to a certain extent at Nome laborers are employed throughout the year, and these men are to a less extent affected by the cost of transportation. As, however, the force employed during the summer months is always very much larger than that employed during the winter, the rate of wages is determined to a large extent by the summer conditions.

In addition to the $5 and $6 a day wages, the laborer also receives his subsistence, the cost of which is directly determined by the transportation charges. It is probable that in some of the camps near Nome the cost of subsistence does not exceed $1 or $1.50 per man per day, but in most of the Yukon camps it is usually estimated at $2.50 to $3.

The high cost of transportation also affects the cost of fuel, which is an important element in operating large plants. Seward Peninsula has no local fuel supply except a scanty amount of timber in the eastern part and a small coal field in the northeastern part. Most mining operations utilize coal brought from British Columbia or Washington or oil brought from California. This coal costs from $15 to $18 a ton landed at Nome. To this cost must be added the price of transporting the coal from the beach to the scene of mining operations. The Yukon camps, on the other hand, depend entirely on the local fuel supply. Up to the present time the timber has been sufficient to meet the demands, but the available timber is being rapidly consumed, and it will not be many years until wood will have to be brought a considerable distance or some other source of fuel found. The cost of wood on the Yukon is variable, and no general figures can be given. It is probably safe to say that it ranges from $7 to $12 a cord delivered at the mines. It must be noted that the Yukon timber is all soft wood and of low fuel value.

Among the many factors that affect mining is the frozen character of the ground. The permanent ground frost has been briefly described in the various publications relating to Alaska, and its general occurrence throughout the Yukon basin and Seward Peninsula noted. As a matter of fact, however, the ground is not all frozen, though

probably much the larger part of it is. But the laws governing the distribution of ground frost have not been determined. Where the ground is permanently frozen the frost usually extends to bed rock, which in one place in the Fairbanks district is known to be 325 feet deep and on some of the benches at Nome more than 150 feet. This ground frost, while it is advantageous to underground mining, increases the cost of most other forms of exploitation, especially dredging. However, although a few years ago it was considered impossible to dredge frozen ground profitably, experience has shown that this is not always the case.

NOTES ON PRESENT COSTS AND METHODS OF PLACER MINING.

With the exception of the Fairbanks district and some parts of Seward Peninsula, but a small percentage of the mining operations in the central and northern portion of the Territory have progressed much beyond the open-cut method, the work being done largely by manual labor, but also by ground sluicing, horse and steam scrapers, steam hoists, etc. During the last three years the methods of mining the deep gravels of the Nome and Fairbanks districts have been much improved. Artificial thawing is carried on with a more complete utilization of the fuel than formerly, steam hoists are in general use, and in most places the buckets are self-dumping. In addition to these simpler forms of equipment, dredges, steam shovels, and hydraulic plants are being successfully operated in various parts of the Territory. Hydraulicking has long been carried on in southeastern Alaska and in the Cook Inlet region and has recently been introduced into the Nizina district of the Copper River valley. It has been less extensively used in the Yukon districts, largely because of the lack of sufficient water under head. In Seward Peninsula also a number of hydraulic plants have been successful, though the available water supply does not, as a rule, encourage this form of exploitation. In addition to these true hydraulic-mining operations, the use of water under pressure for moving alluvium in combination with other forms of extraction is a common practice throughout Alaska where conditions permit.

The dredging of some of the auriferous deposits in Alaska has long been advocated and many experiments with this form of exploitation have been made during the last decade. Up to three or four years ago most of these attempts were either total failures or met with little success. This result discouraged even experienced mining men, and there grew up a feeling of general skepticism as to the adaptability of this form of recovery to the auriferous alluvium of the northern placer fields. The arguments for and against dredging in Alaska have been set forth in the technical press, as well as in the publications of the Geological Survey. In spite of the adverse opinions and the

failures of the first attempts, many experienced engineers persisted in the opinion that dredging was economically possible, though experimentation to meet the local conditions must be carried on. These men have now been proved to be in the right, for a number of dredges are being successfully operated in Alaska and adjacent parts of Canada.

At present the largest dredging enterprises in this northern field are in the Klondike district, where conditions affecting operation are similar to those in the Alaska part of the Yukon basin. Several dredges have been in successful operation in the Fortymile region, in both Alaskan and Canadian territory. In Seward Peninsula two large dredges were operating during the summer of 1908, one of which has been successfully used for three years. A number of small dredges are in use in Seward Peninsula, and other dredges are in construction or planned.

The above facts prove that dredges are to play an important part in the exploitation of these northern placers, but it by no means follows, as seems to be sometimes believed by those inexperienced in their use, that all auriferous deposits which can not be economically exploited by other methods are suitable for dredging. Unfortunately, the success of these dredges may lead to many ill-advised dredging enterprises promoted by inexperienced men, and a mania for dredge construction may develop, similar to that for ditch construction which prevailed in Seward Peninsula a few years ago. If this proves to be the case, much money will be wasted, and the placer-mining industry will suffer. In spite of the failures that will undoubtedly come, a legitimate dredging industry will nevertheless grow up under the guidance of experienced engineers, for there can be no question that there are large areas of auriferous gravel, both in the Yukon basin and in Seward Peninsula, which can be profitably exploited by dredging. Some of this gravel is thawed, but probably the larger part is frozen. In the past the necessity of thawing the alluvium has seemed to be prohibitive to successful dredging. It now appears, however, that under favorable conditions the cost of thawing may be low enough to permit the economical dredging of alluvium whose gold tenor is so low as to prohibit any other form of exploitation. It must be conceded, however, that so far the most successful dredging operations in Alaska have been in thawed ground.

During the first four or five years of extensive mining the cost of artificial thawing was generally estimated at 25 to 40 cents a yard, depending on the character of material, the price paid for fuel, etc. Recent developments at Dawson, Fortymile, and elsewhere indicate, however, a much lower cost for artificial thawing. T. A. Rickard, who last summer made a comprehensive study of the more

important placer districts of the North, reports the cost of thawing dredging ground in the Yukon basin with steam at 9½ to 12 cents a yard.[a] These figures should not be exceeded in Seward Peninsula. Wood for fuel in the Yukon district costs from $7 to $12 a cord, which is equivalent to coal at about $18 to $24 a ton, whereas the average price of coal in Seward Peninsula is only $15 to $18, and petroleum is probably still cheaper per heat unit.

A still greater reduction in costs can be counted on where thawing by exposure to the air and sun is possible. This practice has long been in vogue in open-cut mining. For this purpose the nonconducting surface mat of vegetation is removed by ground sluicing when possible—by scrapers and manual labor when necessary—and the frozen ground, thus exposed to the long Arctic day, rapidly thaws. The depth to which such natural thawing will take place without further stripping varies according to the character of the material. Rickard states that on a property which he visited in the Klondike natural thawing by this means will reach a depth of 14 feet in two years. An improvement on this method is possible where sufficient water is available. The plan formulated by O. P. Perry, the engineer of the Yukon Gold Company (Klondike), is thus described by Rickard:[b]

> The method of using water in preparing the ground for dredging will be as follows: First, stock lines will be laid along the edge of the creek carrying water under high pressure, tapped from the main trunk line. The moss and muck will be stripped by "piping" (that is, the use of a large volume of water under pressure), driving from both sides to a longitudinal cut down the center of the claims. This work will be carried forward about 2 miles ahead of the dredges. When the ground has been stripped, the water will again be applied (at the lower end first), so as to crosscut the gravel with trenches at intervals of from 20 to 50 feet. The effect of this exposure of faces of gravel to the air is to accelerate the natural thaw. After the cross trenches have been made, the longitudinal trench will be deepened so as to drain the entire area. The depth of the trenches and the extent to which this work is carried will depend upon the depth to bed rock and the rate of thaw. Experience thus far indicates that when the stripping has been completed, not much trenching is necessary to carry the thaw to bed rock when the gravel is not more than 18 to 20 feet deep. Each successive season will extend the thaw farther, so that the depth and amount of trenching will depend upon the nearness of the dredge. By this method the total cost of preparing the ground for dredging should not exceed 5 cents per cubic yard, for there is no installation and maintenance of sluices, and many of the other expenditures incidental to hydraulic mining are lacking. The actual work of mining is done by the dredge, the amount of ground moved in the preliminary operation being small compared to the yardage dug subsequently by the dredge itself. By thus making the most of the natural thaw and preparing the ground for rapid dredging, the total cost of mining the gravel should not average more than 20 to 25 cents per cubic yard. The result obtained with artificial thawing in advance of dredging actually shows a cost of 19 to 35 cents per yard.

[a] Rickard, T. A., Dredging on the Yukon: Min. and Sci. Press, vol. 97, 1908, pp. 290–293, 354–357.
[b] Op. cit., p. 355.

There is every reason to believe that this method of natural thawing will be a success, though it has not yet been tried in a large way. Its difficulty of general application to Alaska is the scarcity of sufficient water under head to permit any such extensive channeling as is planned in the Klondike. This feature of the operations of the Yukon Gold Company has probably less bearing on the dredging problems of the Alaskan Yukon than have some others. It certainly is of great importance to know, as Rickard points out, that the actual cost of operating dredges in frozen ground is as low as 19 to 35 cents a cubic yard.

Lest the above-quoted figures for thawing be considered applicable to all forms of mining, it may be well to state that in Seward Peninsula the mean of the figures furnished by several experienced operators in drift mining was nearly 35 cents a cubic yard. It is generally recognized that thawing for deep mining is far more expensive than for dredging. There are no figures available on the cost of thawing for dredging in Seward Peninsula, where, indeed, the frozen condition of the ground is generally regarded as a serious if not an insurmountable obstacle to dredging.

In Seward Peninsula the cost of dredging alone is generally placed at 20 to 25 cents a cubic yard, with probably a considerable reduction by the use of central power plants, either hydroelectric or using imported or local coals. Rickard places the present cost of dredging in the Yukon basin at 18 to 32 cents a cubic yard, with possible reductions to 10 or 15 cents.

Among the many important factors to be considered in dredge mining is the character of the bed rock. The schists that form the predominating country rock in many of the placer districts weather deeply and are readily excavated. In some operations, however, the fact has been overlooked that in the absence of definite knowledge to the contrary, other types of bed rock, such as massive intrusive rocks or blocky limestones, may predominate. The difference between success and failure may rest solely on the character of the bed rock. Of course, no dredging enterprise should be launched without the exhaustive prospecting which will give definite information as to the dimensions of the alluvial deposit, its gold tenor, the character of the bed rock, etc. There appears to be no reason why the speculative element should not be practically eliminated from a dredge-mining enterprise, provided it be in the hands of a competent engineer.

It has been shown that true hydraulic mining has been carried on at comparatively few places in Alaska, though it has been extensively used to supplement other forms of exploitation. Nor does it seem likely that this method of mining will ever be extensively practiced in the Territory. The low gradients make it difficult to dispose of

the tailings, and the small amount of water available under head in most of the important placer fields makes it probable that hydraulic mining will never be an important feature in the districts which are now productive. There are, however, exceptions to this rule. In southeastern Alaska, in the Cook Inlet region, and in portions of the Copper River district there are considerable bodies of gravel, which are so situated that they can be economically handled by hydraulic means, and water is also to be had. South of the Tanana, along the northern slope of the Alaska Range, there are extensive bodies of gravel, some of which are auriferous and are favorably situated for hydraulic mining. It appears, however, that it has not been determined that these gravels carry values.

Bench gravels occur in most of the Yukon districts, as well as in parts of Seward Peninsula, and for some of these deposits water for hydraulicking is available, though in most places the water supply is insufficient to assure continuous operation throughout every field season. Many of these gravel deposits can, however, probably be economically handled by utilizing the water either directly during wet periods or by storing it in small reservoirs, but this will mean mining on a comparatively small scale. The possibility of hydraulic mining by the use of pumped water is dependent on cheaper power than can now be had, but, as will be shown, there are places where hydroelectric or steam plants, using local fuel, can be developed. No data are available on the cost of hydraulic-mining operations, which vary so greatly in different parts of Alaska that, even if detailed facts were at hand regarding the operation of successful plants, they would probably have little general bearing. If allowance is made for difference in wages, the cost of transportation, etc., there is no reason why the handling of gravel by hydraulic methods should be more expensive than in other regions of similar topography, provided sufficient water is available during the open season.

The removal of the overburden by hydraulic means, such as ground sluicing or elevators, has been a general practice. Hydraulic elevators have been considerably used in many parts of Seward Peninsula and to a less extent in the Yukon basin. The cost of these operations will not here be considered, but it is generally conceded by engineers that it is not an economical use of water. It should be noted that in Alaska the term hydraulic mining is often applied to operations in which, as a matter of fact, water under head is used only to remove the overburden. The gravels carrying the values are then handled by open-cut methods, being shoveled or scraped into sluice boxes. This is of course an expensive method of handling ground, yet its extensive use among experienced men indicates that it has a legitimate place in Alaskan placer mining.

Deep gravel mining is confined chiefly to the Fairbanks district, where the alluvial deposits range from 15 to 300 feet in depth, averaging about 100 feet. In these gravels the high values are chiefly concentrated in the lower 4 or 5 feet, and hence they can best be mined by stoping. Messrs. Prindle and Katz report (see p. 199) that the lowest-grade ground now mined by this means yields about $3.50 to the cubic yard. The chief criticisms to be made of the methods employed are that the ground is usually not prospected except by working shafts and that only the richest pay streaks are extracted, leaving the ground in very poor condition for future exploitation. During the last two years churn drills have been successfully introduced for tracing the pay streaks, and by this means the cost of prospecting is much reduced. The distribution of live water is another feature to which little attention has been paid. Very often water is encountered in sinking, and the workings have to be entirely abandoned, because no method has been provided for handling it. Hoisting is done by steam, and automatic dumping buckets are generally used. In many places the water pumped from the mine is used for sluicing, and this plan makes the operations independent of a surface supply, though the necessity of using pumps much enhances the cost of extraction. Similar methods have been extensively used on the ancient beach placers near Nome and to a small extent in other districts.

Much of the mining in the Fairbanks district is done on borrowed capital at an excessive rate of interest,[a] which largely increases the operating costs. Another feature of mining at Fairbanks, and to a less extent in Seward Peninsula, is that many of the operators are working under leases or "lays," as they are locally termed. These men usually have little capital and some of them no great amount of experience. Working, as they do, on borrowed capital with high interest charges, they are compelled to leave untouched all but the richest gravels. Moreover, as they have no interest in the future of the mining claim, they pay small heed to the condition in which they leave the ground. As a rule the leases are made for one or two seasons only. The lessees as a class exploit only the bonanzas, and after they get through their work the ground is so gutted as to make the recovery of the remaining gold difficult and expensive. Mining of this type, while it makes for rapid production, is ruining some of the best properties in Alaska for future exploitation.

Operating costs can be roughly classed under three headings—labor, supplies, and equipment. It will be at once recognized that the cost of all these items is in a large measure determined by the transportation charges. Transportation is the most important factor in considering possible economies in mining methods. It not only deter-

[a] In 1908 the usual rate of interest was 2 per cent a month.

mines the direct cost of labor, supplies, and equipment, but also indirectly affects the cost of these items because of the losses of time frequently involved. This indirect influence of transportation on cost may be illustrated by the course taken when a mining plant is to be installed. After the equipment has been assembled at some convenient seaport on the coast, it is shipped by steamer and by river boat to the nearest place to the property to be developed in Alaska that is accessible by water communication. If the plant is a large one, this transportation may take the best part of the first summer. Where there are no local railways, the equipment is then transported by horse sled to the mine during the following winter. A second summer is usually consumed in installing the machinery. If, therefore, the plant, and then only if it be a small one, is ready for operating at the beginning of the third season, its installation will not have required much more time than is usual in such an enterprise. Time may be saved, however, in Seward Peninsula and at Fairbanks on properties that are accessible to the railroad; such plants may be in operation before the close of the second season. It is evident that the loss on interest charges for a large investment is considerable under the conditions outlined above.

The present price of labor in the more important placer camps in Alaska varies from $5 to $6 a day, with board, making a total cost per man per day of $6 to $8.50. This may appear to be a high charge for manual labor—for much of the work requires little skill [a]—yet it must be remembered that the price is largely determined by the demand for laborers during the open season. On an average twice or three times as much labor is required during the summer months as during the winter. As a result this labor either has to be imported in summer, or must be supported during the winter by the wages earned in the open season. It costs from $40 to $75 to bring in a laborer for the summer work. Moreover, he can not reach the camp until some weeks after the mining season has opened. These conditions make it improbable that the cost of labor will be reduced, unless there is a material change in the transportation situation, or more encouragement is given to the individual miner to prospect for himself for a part of the season. Railway communication with the camps appears to be the only solution of the labor problem. If a laborer could be brought from Seattle to Fairbanks at the time he was needed, in four or five days, and returned, when there was no more work for him, in the same length of time, at a cost of, say, $50, he could afford to work for considerably less than he now receives. The cost of food for the laborers would also be reduced if railroad transportation were available. Such facilities

[a] This statement applies more especially to open-cut work; the deep mining at Fairbanks requires skilled miners.

appear to be very remote for Seward Peninsula, but the outlook for a railway to the Yukon is more hopeful.

It should be stated that the completion of a wagon road between Valdez and Fairbanks, now begun by the Alaska Road Commission, will in a measure tend to reduce the cost of labor. Even now, as the winter trail is good, many men make their way to Fairbanks late in the winter for employment when the open season begins.

If lode mines are developed in any part of the inland district of Alaska or Seward Peninsula, they will furnish employment throughout the year and thus materially help the labor situation. This opportunity would attract a more permanent laboring population, which is now almost lacking in the placer districts. The greatest need of the Fairbanks district, as well as of others in the Yukon basin, is a larger population. There are now hardly men enough to work the developed placers, much less to prospect. Although it is true that the deep placers of Fairbanks are operated throughout the year, winter mining appears to be rather on the decrease, and it seems probable that unless lode mines are developed, there will be less employment during the winter months in the future than there has been in the past.

The outlook does not appear very hopeful for a material reduction of the percentage of manual labor employed in placer mining. This statement, of course, does not refer to dredging, and, as has been shown, the employment of labor-saving devices is constantly increasing. Unfortunately, the water supply is not such as to encourage the outlook for hydraulic mining, though there are possibilities of developing cheaper power. It appears, therefore, that in the two important placer fields the most promising feature for the reduction of cost is the introduction of dredges where their use is economically feasible.

The high freight charges can best be appreciated when it is stated that the cost of transportation of supplies delivered at the mine will vary from $75 to $500 a ton, or even more in some of the isolated camps. The reduction of these costs is dependent on additional railways and wagon roads, and those already completed and now in progress have materially lessened operating expenses in some of the placer camps. Even were the cost of transporting a ton of supplies by rail from the seaboard to Fairbanks as much as that of bringing it by the long water route, yet there still would be a saving, because of the saving of time and the certainty as to the date of delivery. It is estimated that the transportation of supplies and equipment to Fairbanks costs the district nearly $2,000,000 annually, and to this must be added about $1,000,000 more for transportation of that part of the freight which is sent to the creeks. In other words,

about 30 per cent of the value of the entire gold production of the Fairbanks district is required to pay the transportation charges alone.

Another direction in which economy in mining may be introduced is by lowering the cost of power. There are two ways in which this may be done—one by the utilization of water power and the other by the reduction of the cost of fuel or, what amounts to the same thing, greater economy in its use. The investigations made by the engineers of the Geological Survey have shown that there are probably available water powers both in the Fairbanks district and in Seward Peninsula. (See pp. 227 and 373.) It is likely, however, that, even if all the water powers available are harnessed, there will in time still be demand for more power. Moreover, the utilization of these water powers presents many difficult problems, some of which have not yet been studied in detail.

The lowering of the cost of fuel does not seem feasible. At the rate at which the timber is being used up in the Yukon region the chances are that the cost of cord wood will continue to go up, as it has during the past few years. Here, again, the item of transportation has added to the cost to a very large degree, and the improvement of the wagon-road system and the introduction of railroads may have a material effect on the price of fuel. This is especially true in Seward Peninsula, where most of the fuel is imported from Puget Sound and other places. The more economical use of fuels is probably another direction of possible saving, but falls outside of the present discussion.

Another method that might reduce mining costs is the utilization of local deposits of lignitic coal for the production of electric power to be transmitted to the mining camps. A plan has been under consideration during the past year for using the Chicago Creek coal in the northeastern part of Seward Peninsula in this manner. (See pp. 362–364.) Similar coals occur south of the Tanana within 30 or 40 miles of Fairbanks. If Seward Peninsula and the Yukon districts, as is believed, include considerable areas of dredging ground, it is possible that such local supplies of lignite may furnish the needed power. In any event, it appears that it would be more economical to utilize the lignitic coal in a power plant located at the mine than to attempt to transport it to the various districts. A company undertaking such an enterprise will naturally make a careful study of the possible competition of a coal-consuming power plant with any water powers that may be developed.

MINERAL-LAND LAWS.

The inadequacy of the public-land laws under which placer ground is preempted and held is seriously retarding mining advancement. At present large tracts of public land in regions believed to be aurifer-

ous are located and held by individuals and groups of individuals for purely speculative purposes, without any attempt at mining development or even the proving of the mineral character of the land. This is clearly an evasion of the spirit of the mineral-land statutes, whose sole purpose was to bring about the discovery and development of the mineral deposits. It is difficult to prove that there are many cases of actual evasion of the letter of the law, though it is generally conceded that some statements of annual assessment work performed will not bear close scrutiny.

To understand the present conditions it is necessary to bear in mind the fact that but a small percentage of the placer claims are ever patented. Hundreds and thousands of claims have changed hands, and in many of them all the gold has been extracted without any title having been acquired, except through the original staking and the annual assessment work required by law. In districts of mining activity the annual assessment work is usually performed, for every property is watched closely by a numerous class of so-called professional "claim jumpers." In the more isolated districts, however, many claims are staked and restaked by the same individuals without the slightest attempt at prospecting the ground. One instance may be recited where, in an isolated district of no mineral production but possible values, the claim holders had a "gentlemen's agreement," by which they agreed to do no assessment work and not to jump each other's claims, restaking the first of each January. If, however, a stranger appeared in the district, each man betook himself to his property and either restaked it or went vigorously to work.

Some years ago it became the established practice to take up public land believed to be valuable for placers in so-called "association claims" of 160 acres, for it was found that the present law allows the same amount of assessment work to hold the larger tract as the individual 20-acre claim. As it is easy to obtain powers of attorney for staking placer ground, either from residents or nonresidents, and as there is no limit to the number of claims that such an association of individuals can locate, there is nothing to prevent one man preempting thousands of acres, provided he be first in the field. As a consequence the systematic prospecting of supposed placer ground previous to location and recording, is almost unknown in Alaska. When a so-called "stampede" into a new district takes place each man strives to be the first on the ground, and to stake as many claims as his ability to travel across country will permit. Having located the ground, the "claim staker" is not required to do anything, except to make record with the United States commissioner, until a year from the first of the following January, when he may continue to hold his 160-acre claims by doing $100

worth of assessment work on each claim. As has been shown, even this requirement is often evaded.

The bona fide prospector is usually later in the field, for he is burdened by his prospecting equipment and supplies, whereas the claim staker needs only a pencil and hatchet and a few days' provisions. These later arrivals are then given opportunity to prospect under a lease the claims already taken up. If the ground proves to be valuable, the claim staker and his associates, who may be thousands of miles away, receive a royalty from mineral lands on which they have usually expended nothing but a few days' or weeks' time. On the other hand, the man who prospects the claims under lease receives nothing for his labor if the ground is found to be worthless, and at best his reward is usually little more than the average wages of the district. In an unproved field it is often difficult to find prospectors to work under a lease, and as a consequence, though the lands are taken up under mineral entry, no mining is attempted for a year or two. That this account is not overdrawn will be admitted by all who are familiar with the conditions. Mr. Maddren elsewhere in this volume (pp. 234 and 238) describes the conditions in some of the newer placer camps.

All this is clearly an evasion of the purpose of the statutes, but it probably can not be rectified except by a change of law. As a matter of fact, the laws under which the mineral lands of the public domain are acquired by the individual are of a very general character, and it was intended that they should be supplemented by state and territorial statutes, or, in the absence of other forms of local government, by the regulations of the "miners' meetings."[a] Alaska has, of course, no local government, but up to 1900 it was the general practice for the miners of each district to elect their recorders and make regulations with reference to size of claims, etc. These regulations had a standing in law so long as they did not conflict with the United States statutes. In the pioneer days, with the small population of miners and prospectors, this system worked admirably. With the sudden influx, during the Klondike and Nome excitements, of a large population which had not been schooled to frontier conditions, regulations by "miners' meetings" were far less successful and fell into disuse. The civil code of Alaska, enacted in 1900, still recognizes the right of miners to make local regulations,[b] but advantage is now seldom taken of this privilege, largely because miners of the best class realize that it is no longer applicable to the present conditions.

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[a] See Rev. Stat., sec. 2324.

[b] See An act making further provision for a civil government for Alaska and for other purposes, Title I, sec. 16, Stat. L., 56th Cong., 1st sess., p. 328.

These conditions have undoubtedly discouraged systematic prospecting in Alaska placer districts, and as a consequence the number of real prospectors and miners appears to be decreasing. It is unfortunate that in a region where there are such great fields that should receive careful investigation by experienced men, such men are not encouraged to prospect. There are hundreds of miles of valley bottoms staked for placers where no attempt has ever been made to excavate to bed rock. The nominal holders of many of these claims are residents of the towns, if they live in Alaska at all, and support themselves by other means, while the experienced miner, if he desires to work for himself, is forced to seek very isolated districts which the professional claim staker has not reached.

Of the necessity for a change in the statutes and regulations applying to the taking up of placer ground, nearly all familiar with present conditions are agreed. There is, however, far from unanimity of opinion as to the changes that should be made. It seems to be generally agreed that the advantages of the association claim are less than its disadvantages and that the former practice of taking 20-acre claims is best. There can be no doubt that for the encouragement of gold dredging the larger claims would be desirable. If, however, in the statutes no difference is to be recognized between ordinary placer ground and dredging ground, the larger claim would best be abandoned. It appears also that a man should not possess the unlimited right of staking claims for himself or his friends. If only 20-acre claims were permitted and a more rigid assessment law was enforced, attempts to preempt large tracts of the public domain would be somewhat discouraged. The speculative feature in an unproved district would, however, still remain and tie up the supposed mineral land for a year or two. Possibly the difficulties could be met by requiring the assessment work to be done within six months or even three months from the time the claim is staked. Any statute that reduces the time in which assessment work is done should take cognizance of the fact that in some localities the work can best be done in winter, in others only in summer.

In his recent report [a] the governor of Alaska recommended that a law be enacted defining the length of tunnel or depth of shaft which shall constitute the assessment work.[b] Such a law has long been in force in the Yukon Territory, where conditions of mining are practically the same as in Alaska. It should be noted, however, that Canada maintains a regular force of trained engineers and inspectors to see that the mining laws are obeyed. That an inspection of assessment work would be desirable can not be doubted, but it can

[a] Report of the governor of the district of Alaska to the Secretary of the Interior, 1908, p. 16.

[b] If this were enacted in a law, other methods of prospecting, as by churn drill, dredge, etc., should also be recognized.

hardly be expected that the few underpaid United States commissioners, who are at present charged with a great variety of duties, could undertake such an additional task, even when fitted for it by training and experience.

SUMMARY OF PLACER MINING BY LOCALITIES.

PACIFIC COAST REGION.

For the purposes of this discussion, the Pacific coast region will here be made to include not only the seaboard but also the drainage basins tributary to it. No extensive placer fields have been developed in this region, but there are a number of small districts whose aggregate production in 1908 was valued at about $450,000, as compared with $275,000 in 1907. The increase is to be credited entirely to the Susitna basin, and for the most part to Valdez Creek. The placers of the Copper River region included in this estimate of production are described by Mr. Moffit on p. 156.

Southeastern Alaska.—The only placer-mining operations in southeastern Alaska during 1908 were on Gold Creek, in the Juneau district, where some hydraulicking was done, and on Porcupine Creek, a tributary to Klehini River, in the Skagway district. In former years there was considerable mining on Porcupine Creek and 30 miles northwest of Haines, but since 1904 there has been only a small production from this locality. In 1908, however, a flume 6,280 feet long, 38 feet wide, and 7 feet deep was completed along the sides of the creek bed, and through it the stream is diverted, thus giving access to the auriferous creek gravels. A little sluicing was done at the close of the season, and a small output is reported.

Beach mining.—Beach placers are widely distributed along the Pacific seaboard, notably at Lituya Bay, Yakataga, Yakutat, Anchor Point, Cook Inlet (see p. 148), at a number of localities on Kodiak Island (see p. 30), and on Popof Island, near Unga (see p. 149). So far as these placers have been studied, they appear to be mere surface concentrations due to wave action. Prospectors report that enrichment of deposits of this type takes place after heavy storms. Under such conditions the waves cut back into the coastal-plain sediments and concentrate the heavy material as a surface layer. Several attempts have been made to mine these beach deposits in a large way with the use of machinery, but they have all failed, probably because the quantity of material at any one locality is very small. It is worthy of note that these deposits do not compare in bulk or richness with the famous beach placers of Nome. Aside from the fact that the mining of the Pacific beaches furnishes spasmodic employment to possibly half a hundred men who are probably otherwise engaged for most of the year, these placers appear to have no great economic

importance. Their occurrence is of interest, however, because they indicate that certain regions are auriferous which have so far yielded no gold except from such deposits. The population engaged in beach mining is so ephemeral in character that there is no means of obtaining statistics of production. Yakataga still seems to be the chief center of this industry, but some beach mining is also done on Kodiak and Popof islands. The total output from the beach placers in 1908 is estimated at $20,000 to $30,000.

Sunrise district.—The Sunrise placer district, in the northern part of the Kenai Peninsula, continues to be a small producer. Several small hydraulic plants are operated, but most of the gold is taken by more primitive methods. Mills, Canyon, Lynx, Gulch, East Fork, and Sixmile are the productive creeks of the district. It is estimated that about 50 men were engaged in mining during 1908, and that 10 claims yielded more or less gold. The value of the entire output of the district is probably about $20,000.

Susitna basin.—The exploitation of some rich placers on Valdez Creek, a tributary to the upper Susitna, and the continuation of mining in the Yentna and Little Willow Creek basins has stimulated prospecting throughout the Susitna River basin. Discoveries of workable placers in various parts of this region are reported, but details are lacking. Several small steamers are now used on the Susitna, and a more complete water-transportation system is promised for 1909. According to current reports, a number of large steamers are to be placed on the Susitna and a comparatively easy route to the Valdez Creek and Yentna placers is to be established. The Valdez Creek placers are described by Mr. Moffit elsewhere in this volume (pp. 157–160).

There is little information at hand regarding the Yentna district. One or two hundred miners and prospectors were reported to be in this district in 1908, and the value of the gold output is estimated at $100,000.

YUKON BASIN.

The total output of gold from the Yukon region in 1908 is estimated to have a value of $10,200,000, as compared with $9,183,000 for 1907. This increase of a million dollars must be credited entirely to the area tributary to Fairbanks, which is described by Messrs. Prindle and Katz elsewhere in this volume (p. 181). Most of the smaller districts showed a falling off in production as compared with previous years, largely because of the scarcity of water for sluicing, but partly because on certain groups of claims that have been consolidated for exploitation in a large way the equipment has not yet been installed and so there was no output. Outside of the Fairbanks district the most important features of the mining industry in the Yukon basin

were the successful operation of dredges in the Fortymile district, some discoveries of placer ground in the Hot Springs district of the lower Tanana Valley, the finding of auriferous gravels in the Beaver Creek basin, and the exploitation of some deep gravels carrying a high gold tenor in the Koyukuk district.

Fortymile district.—It has been found impossible to obtain complete data on the gold output of the Fortymile district. Reports received from 20 different operators show an aggregate output of $66,000. It is believed, however, that there were at least twice as many operators and that the value of the production was greater than that of 1907, which amounted to $140,000.

Two dredges were operated for most of the season on Walker Fork and are said to have been successful. A smaller prospecting dredge was used for a part of the summer near the international boundary. The dredge on Pump Bar, Fortymile River, installed in 1907, was wrecked by the spring freshets of 1908. It appears that the Fortymile district was better supplied with water during 1908 than any of the other Yukon districts, and this led to many small operations. As in previous years the most work of this kind was on Wade Creek, but the Ingle, Napoleon, Chicken, Lost Chicken, Berkshire, Meyers, and Flat Creek placers also were productive. Some mining was done on American, Nugget, Flume, and Barney creeks, near the town of Eagle. These operations were all on a small scale, the total production being about $10,000.

Circle precinct.—Returns were received from only 14 operators in the Circle precinct. It is believed, however, that about 30 different mines were productive in 1908. This is another instance to show that neglect of the individual operators to furnish statistics of production is liable to result in injustice to the precinct in the Survey reports. Fortunately the writer has had the cooperation of A. J. Childs, Samuel Sim, and others in procuring general estimates of production, and these data indicate a total output for the precinct of $175,000 in 1908 as compared with $200,000 in 1907. Nearly half of the output was obtained by drift mining during the winter months. The decrease is chargeable to the lack of water for sluicing during the open season. (See p. 216.) It is estimated that 36 different mines, employing 110 men, were worked during the summer af 1908, and that during the preceding winter 24 mines, employing 64 men, were on a productive basis. Winter work on Deadwood Creek was hampered by the mild weather, as the seasonal frost did not reach bed rock until February and the ground water prevented mining.

The completion of about 20 miles of wagon road from Circle, on the Yukon, to Jenny Jump, Birch Creek, will help to solve the transportation problem in this region. A wireless station, which

has been installed at Circle, will put the precinct into telegraphic communication with the outside world.

As in previous years, Mastodon Creek made the largest production and Deadwood Creek was second. Some prospecting was done on the lower part of Deadwood Creek to test the ground for dredging. There has also been considerable prospecting in the Birch Creek district, with a view of finding dredging ground. This district includes considerable bodies of gravel 12 to 40 feet in depth that carry values too low for operating by the open-cut method, and some of this gravel is thawed. The small amount of water and the low grades of the streams will probably make it impossible to hydraulic these gravel deposits, but it seems possible that some of them may be worked at a profit by means of dredges. In any event, it is certain that parts of the main Birch Creek and Harrison, Deadwood, and other creeks are worthy of investigation. The reported discovery of a small vein of wolframite on Deadwood Creek (see p. 29), is of interest, though not known to be of commercial importance.

A 6-mile ditch was completed in the late summer to bring water from Bonanza Creek, a tributary of Porcupine Creek, to the placers on Mammoth Creek. This ditch gives about 500 feet of working head, and the water will be used to hydraulic an extensive tract of auriferous gravels. It has long been known that the gravels of Mastodon Creek carried values, but there has been practically no mining on this creek since 1905, when a steam-shovel plant was used experimentally on the upper part of the creek. These operations showed that the ground carried gold, but the values were not sufficiently high to permit profitable exploitation by this method.

A storage reservoir was completed on Mastodon Fork of Eagle Creek during the summer, but the season was so dry that the water was sufficient only to do some ground sluicing of overburden. Most of the known productive part of Eagle Creek is now controlled by one company, which has been engaged during the last two years in installing its equipment. The ground formerly worked on Eagle Creek carried values high enough to make it worth while to drift thawed ground, a process which entailed the expense of timbering. In addition to the above-mentioned operations, there was a small production on Woodchopper, Coal, and other creeks tributary to the Yukon above Circle.

An important feature of the mining development in this region in 1908 is the discovery of gold on tributaries of Beaver Creek. It is reported that good prospects are found on Loper Creek, a tributary of Preacher Creek. Here the ground is said to be thawed and less than 8 feet in depth. Pick and shovel mining is said to yield $4 to $5 to the man. Encouraging prospects are also said to have been found on Bachelor Creek, in this same general field. The bed rock

throughout the district is said to be mica schist similar to that occurring on the Birch Creek side of the divide.

Chena-Salcha-Tenderfoot region.—The reported discovery in 1907 of rich placers in the upper Chena basin has not been verified by the later prospecting. There appears to be no doubt that the region is auriferous, however, and as it lies in what would seem to be the normal extension of the Fairbanks gold belt, there is good reason to suppose it may yet yield commercial placers. It can not be denied that the prospecting that has been done during the last two years has not met with any great amount of success. Some of the creeks, however, have made a small production, and there are still in this field a number of prospectors who are sufficiently encouraged to continue their work. The placers of the Salcha and Tenderfoot basins were hampered by the same dry-weather conditions that prevailed at Fairbanks. In spite of this, the production has continued about the same as in 1907, which is estimated to have a value of $300,000 to $450,000. On Tenderfoot Creek, the largest producer, 7 claims were worked by 100 men during the winter and 8 claims, employing about 120 men, during the summer. Two claims were worked on Banner Creek and 2 on Democrat Creek, a tributary of Banner Creek.

Rampart district.—The Rampart district, as here defined, includes the drainage basins of Minook Creek and of some other streams tributary to the Yukon near the town of Rampart. Only seven operators in this district replied to requests for statistical information, giving a total production of $9,000. This, of course, represents only a part of the total output of the district. It seems probable that the production of 1907 was nearly twice as great as that of 1908.

Mining was almost entirely suspended in this district during July and August because of low water. (See p. 226.) The more important operations during the rest of the summer included work with two hydraulic plants on Hunter Creek and one with an elevator on Hoosier Creek. Three automatic dams were in operation on Little Minook Creek and one on Hoosier Creek. A small amount of open-cut manual work was done on Ruby, Slate, and Little Minook, Jr., creeks. Some sluicing was also done on Quail Creek.

During the last two years some prospecting has been done on Morelock and Shevlin creeks, which flow into the Yukon from the north about 20 miles above the mouth of the Tanana. The gravels of these streams have been found to be auriferous, and some sluicing was done in 1908 on a bench claim at the confluence of Morelock and Bonanza creeks.

Hot Springs district.—The Hot Springs district is comprised in the basins of Baker Creek and other tributaries of the lower Tanana. This region was a focal point of interest during the summer of 1908,

and there was a considerable influx of miners from other parts of the Yukon basin. In 1907 good prospects were found on Sullivan Creek, and in 1908 these placers made a considerable production in spite of the low-water conditions. In addition, other workable deposits of auriferous alluvium were found in the region lying between Sullivan Creek and the northern tributaries of Baker Creek. The auriferous belt thus roughly blocked out stretches from Sullivan Creek to Elephant Gulch, being about 25 miles long and 5 to 10 miles wide. Within this area some rich ground has been found, notably on Glenn and Thanksgiving creeks, as well as on tributaries of Pioneer Creek, and the district promises to become a large producer.

The low-water conditions of 1908 (see p. 213) prevented any very extensive mining operations, but the total production for the year is estimated to be about $150,000, about one-sixth of which was taken out during the winter. It is estimated by W. B. Ballou, United States commissioner at Hot Springs, that 4 claims were worked during the winter by 8 men and 12 claims during the summer by about 100 men, including those that were doing dead work.

On Thanksgiving Creek a considerable area was stripped of moss preparatory to ground sluicing and a bed-rock flume was excavated. Water was almost lacking, so very little sluicing was done. On Glenn Creek, Seattle bar, and What Cheer bar some open-cut mining was accomplished. On Eureka Creek two open-cut plants were in operation when water permitted, and an extensive system of flumes was installed. A mile of ditch was built on Sullivan Creek for open-cut mining on Tufty Gulch. Several smaller ditches were also in part completed on Sullivan Creek, where during the winter some deep mining was done, considerable ground was stripped, and some bed-rock flumes were excavated.

Bonnifield and Kantishna region.—The Bonnifield and Kantishna placer districts, lying along the northern margin of the Alaska Range, continue to encourage a small mining population. Gold has been found on six or seven creeks, and a small production is made annually. No rich diggings, however, have been found except on a few claims located the first year in the Kantishna region. The large bodies of gravel, though known to be auriferous, have not been proved to carry gold in commercial amounts, and the most encouraging feature of the gold deposits of this district is their close proximity to the high mountains, which will furnish a water supply for hydraulic purposes—a condition almost unique in the placer-mining districts of the Yukon region. It is estimated that the total value of the gold output of these two districts for 1908 was less than $20,000.

Chandalar district.—According to S. J. Marsh, United States commissioner at Caro, 11 claims, employing 23 men, were worked in the

Chandalar district during the summer of 1908. The largest production came from Big Creek, but there was also a considerable output from St. Marys Creek and a small amount of gold was obtained from other streams in the course of prospecting.

As in the other Yukon camps, scarcity of water considerably curtailed production. The district also labors under a great disadvantage because of the cost of taking in freight. All supplies must now be brought by poling boat in summer or dog team in winter from the head of steamboat navigation on the Chandalar, a distance of 60 miles, or from Fort Yukon, a distance of 150 miles. Considering these disadvantages the production last year of about $25,000 worth of gold is very creditable and exceeds that of the previous season. Efforts are now being made to have a direct road constructed from Yukon River, a distance of about 100 miles, following a route along which a trail has in part been established. The reported discovery of auriferous lodes in this field has already been referred to (p. 30).

Koyukuk district.—There is little information at hand regarding the Koyukuk district beyond the fact of its general prosperity, in spite of the low-water conditions that prevailed during the summer of 1908. This prosperity is due chiefly to the impetus given to prospecting by the discovery of rich placers at a depth of 130 feet on a claim on Nolan Creek. During the fall of 1908 an extension of the rich ground on Nolan Creek is said to have been found.

There were no changes in the cost of operating, which are still very high. The low-water conditions not only curtailed mining, but also disorganized the steamboat transportation service. In former years steamers from the Yukon have usually reached Bettles by June 20, but in 1908 the first boat did not arrive until July 4, and on account of low water was forced to discharge its freight 6 miles below Bettles.

Only eight operators replied to requests for statistics on production in 1908, and their total output aggregated $116,000. It is confidently believed, however, that the output of the district exceeded $200,000, and hence was more than twice as much as that of 1907.

Lower Yukon and Kuskokwim.—Mr. Maddren presents an account of the gold placers of the Gold Hill, Ruby Creek, and Innoko regions elsewhere in this volume (pp. 229–266). The results of his investigations are of importance to the mining industry in indicating the presence of what seems to be a southwesterly extension of the gold-bearing rocks of the Yukon-Tanana region. Though the entire production from these districts during 1908 was less than $100,000, yet the mere presence of gold should give impetus to prospecting. In this connection it may be noted that auriferous gravels have long been known to occur on the Melozitna and also on the Anvik, though no workable placers have been developed.

During the past summer discoveries of rich placers were reported on Tuluksak River, which flows into the Kuskokwim from the east, about 60 miles above Bethel. It appears that some prospectors took out several thousand dollars' worth of gold from creeks in this region with the aid of rockers alone. The information in regard to this find is not very definite, but it is a significant fact that the reported locality of this discovery lies in what would be the extension of the Innoko gold-bearing belt. The district is at least worthy of further investigation.

NORTON BAY.

So far as known, the only productive placers of the Norton Bay region are those of Bonanza Creek, which flows into Ungalik River,[a] the first large easterly tributary to Norton Bay, its mouth being about 10 miles east of Cape Denbigh. The creek is reported to have only a few claims on it, but these have been considerable producers for several years. Gold is also said to have been found near the hot springs in the Tubutulik River basin, but the amount has not been determined.

SEWARD PENINSULA.

The mining conditions in Seward Peninsula during 1908 are fully summarized elsewhere in this volume by Mr. Smith (p. 267) and Mr. Henshaw (p. 355). Mr. Smith shows that the low-water conditions and the approaching exhaustion of some of the ancient rich beach placers largely curtailed the gold production. Great difficulty has been experienced in obtaining accurate statistics of the gold production of Seward Peninsula, owing to the neglect of many operators to furnish statistical data of output, or even to reply to the communications sent to them. At this writing replies have been received from only 77 mine operators, a number which is believed to be only about 50 per cent of those who were producing gold in 1908. (See p. 17.)

KOBUK DISTRICT.

Mention has already been made (p. 31) of the reported discovery of gold and copper bearing lodes in the Kobuk River region. This district, in spite of its inaccessibility, has maintained a small placer-mining population for several years. Supplies for this camp are sent up Kobuk River by steamer to Shungnak, about 200 miles, and thence freighted by poling boats or dog teams to the placer mines. Another route of communication is up Dakli River, a northerly tributary of the Koyukuk, thence by an east portage through Zane Pass and down Pah River to the Kobuk. Data in regard to the mining development in this field are available through the courtesy of Lewis Lloyd and M. F. Moran, of Shungnak.

[a] Locally known as Ungatalik.

The area in which gold placers have been found is, roughly, about 10 miles square and drains into Kobuk River. Of the several streams in this area, Shingnek [a] and Dahl creeks have been found to carry workable placers. The bed rock in the mineralized area is said to be mica schist, slate, calcareous schist, greenstones, and granite, and the statement corresponds to the observations made by Mendenhall [b] during his hasty exploration of this stream in 1901.

There has been some mining on Shingnek Creek for nearly ten years, and the entire production is estimated to have a value of about $50,000. This gold has been taken out of seven or eight claims, located about 9 miles from the Kobuk. The bed rock is mica schist and greenstone schist, and the gravels are only from 1 to 3 feet in depth. Most of the gold is fine, but one nugget has been found which weighed 2¾ ounces. In 1908 three or four men were mining on this stream. The work is accomplished with the aid of wing dams, and periods of high water interrupt operations.

Dahl Creek is about 10 miles in length and its productive placers are distributed along the upper 6 miles of its course. The bed rock is reported to be schist and the gravels from 2 to 8 feet in depth. The gold recovered contains a large proportion of nuggets, and one of these weighed 3½ ounces. At the head of the creek is found angular gold that seems to be practically in place. The adjacent schist is full of quartz stringers, some of which carry free gold. Mining on this creek has been spasmodic. The total production is estimated at about $40,000, taken chiefly from claims Nos. 1, 2, 5, 6, 7, and 8. Values as high as $15 to the shovel are reported.

Placer gold has also been found near the head of the Noatak and at other localities in this district, but not in paying quantities. The occurrence of copper nuggets in some of the stream gravels of the Kobuk district has already been noted (p. 31). The white population of the district is estimated at about 20 men, and the annual gold production at about $10,000 to $15,000. An interesting feature of the mining is that Eskimo [c] laborers are very largely employed, and are said to make very good workmen.

NONMETALLIC MINERAL DEPOSITS.

During 1908 the mining of nonmetallic deposits was confined to the operating of a few widely distributed coal mines, some marble quarries, and a gypsum mine in southeastern Alaska. There was also a small production of mineral waters from southeastern Alaska. The marble and gypsum deposits, described by Mr. Wright elsewhere in this report (see pp. 84–85), show a production valued at $70,000 [d] in

[a] Locally known as Shungnak.

[b] Mendenhall, W. C., Reconnaissance from Fort Hamlin to Kotzebue Sound, Alaska: Prof. Paper U. S. Geol. Survey No. 10, 1902, pp. 31–35.

[c] The native population of this part of Alaska is Eskimo and not Indian.

[d] This is the estimated value of the raw product at the locality of production.

1908, as compared with $63,908 in 1907. The following is a statement of the value of these two products during the last eight years:

Value of marble and gypsum produced in Alaska, 1901–1908.

1901	[a] $500
1902	[a] 255
1903	[a] 389
1904	1,700
1905	710
1906	11,995
1907	[b] 63,098
1908	[b] 70,000
	148,647

In 1908 four coal mines were in operation—the same as in 1907. Preliminary estimates of production indicate that only about 4,000 short tons of coal were mined in 1908, as compared with 10,139 short tons in 1907. The coal mined is used only for local consumption, and the decrease is therefore not significant. One of the coal mines, the largest producer, is on Seward Peninsula (see p. 362); the others are on the Pacific seaboard (see pp. 116–145). In addition to these mines, which are regularly operated and from which statements of production are available, a little coal is extracted for domestic use at probably five or six other localities. One of these is on Wainwright Inlet, in the extreme northwestern part of Alaska, where Eskimo mine a little coal for their own use. Another is at Cape Lisburne, where a little is probably furnished to the local shipping. There are also several places in the Yukon basin and on the Pacific seaboard where a few tons of coal are extracted each year.

The subjoined table shows the production of coal in Alaska for the last twenty years:

Production of coal in Alaska, 1888–1908.

Year.	Amount (short tons).	Value.	Year.	Amount (short tons).	Value.
1888–1896	6,000	$84,000	1904	1,694	$7,225
1897	2,000	28,000	1905	3,774	13,250
1898	1,000	14,000	1906	5,541	17,974
1899	1,200	16,800	1907	10,139	53,600
1900	1,200	16,800	1908	4,000	19,000
1901	1,300	15,600			
1902	2,212	19,048		41,507	315,079
1903	1,447	9,782			

NOTE.—The production for 1888–1896 is estimated on the best data obtainable. The figures for 1897 to 1907 are based for the most part on data supplied by operators; those for 1908 on preliminary estimates.

Mining developments in the Bering River coal field of the Controller Bay region and in the Matanuska coal field of the Cook Inlet region were practically confined to surveys for patents, assessment work, and trail building. The most important features are connected with the problem of railway construction, which has already been

[a] Estimated.

[b] The value for 1908 is in part based on statements from the producers, but the full returns are not obtainable at the date of the publication of this report.

referred to (p. 23). Certain features of the coal-land law have appeared to discourage capitalists from entering into projects of developing these coal fields.

Little advancement was made in the Controller Bay region in 1908. Up to the close of the year no patents for coal land had been granted, and this discouraged all mining and transportation enterprises. A few trails and telephone lines were constructed, however, and a little prospecting of coal beds was done. The construction of railways to the coal field appears to have been practically suspended in the early part of the year, but a survey was made for a new railway to connect the field with a wharf to be located on one of the small islands in Controller Bay.

Some bituminous coal was mined on Bering Lake during the early part of 1908 and shipped to the coast in barges. This output, with that of the previous year from the same source, was important, inasmuch as it made possible the commercial testing of these fuels.

It is reported that more coal has been found in the Matanuska field south of Matanuska River. There was considerable prospecting in this district during 1908, and the results are said to have been encouraging.

The two oil wells near Katalla furnished a small production of petroleum in 1907, which was used for fuel for the construction work then going on in the vicinity. No further drilling has been done in the oil fields, and probably none will be attempted until transportation facilities are improved.

Through the courtesy of E. De K. Leffingwell, who is engaged in making geographic and geologic studies along the north coast of Alaska, the writer has learned of the occurrence of what appears to be a petroleum residue about 100 miles east of Point Barrow. Mr. Leffingwell describes this material as occurring near Smith Bay, in a mound several hundred yards in diameter and standing about 150 feet above the level of the tundra. The material resembles asphalt, but contains considerable vegetable matter and silt. It would appear to be the residue from petroleum which had impregnated peat, and the volatile constituent of which had mostly evaporated. David T. Day made an examination of a specimen of this substance collected by Mr. Leffingwell, and reported the following results:

Composition of petroleum residue from Smith Bay.

Water and water-soluble matter	22
Alcoholic extracts (resins and some oil)	8
Naphtha extracts:	
Light oil	12
Heavy oil	16
Benzol extract (asphaltic material)	11
Clay and vegetable fiber	29
	98

This material resembles that described by Martin [a] from Cold Bay, Alaska Peninsula, which was formed by the soaking of a peat bog in the emanations from a petroleum seepage. At Cold Bay, however, the petroleum has a paraffin base, whereas that at Smith Bay has an asphalt base. It seems probable, then, that the material collected by Mr. Leffingwell owes its origin to a petroleum seepage. Occurrences of similar substances have been reported by whalers from the north coast of Alaska, but the localities are not definitely known. So far as known, the region near Smith Bay is underlain by Tertiary beds.

In this connection, it is worthy of note that W. Howard, U. S. Navy, during his exploration of upper Colville and Chipp rivers, reported a similar occurrence.[b] It seems worth while to quote Dall's description of this occurrence in full:[c]

> Here they found on the surface rather abundantly scattered masses of a brown material resembling powerfully compressed peat, recalling pitch in hardness and weight, but not brilliant nor disposed to melt with heat, but making a clean cut, like "plug" tobacco, when whittled with a knife. This material was sufficiently inflammable to ignite and burn with a steady flame on applying a match to a corner of it, so that in their cold and weary journey it formed a most welcome substitute for wood or other fuel for the camp fire.

These fragmentary data point to the conclusion that there may be a petroleum field in this extreme northern part of Alaska. Were the region not so inaccessible, it would certainly be worth while to investigate these occurrences, but as it is, even if petroleum is found, it could not now be brought to a market.

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[a] Martin, G. C., Petroleum of the Pacific Coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905, pp. 56–57.

[b] The exact locality of Howard's observations is not known, but it is significant that he was also in the neighborhood of Smith Bay during his journey.

[c] Dall, W. H., Report on coal and lignite of Alaska: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, pp. 818–819.

THE POSSIBLE USE OF PEAT FUEL IN ALASKA.

By CHARLES A. DAVIS.

More than 10,000,000 tons of peat are prepared and used annually for fuel in the countries of northern Europe, while in the United States and Alaska not 1,000 tons were used in 1908. The high price of coal and other fuel in Alaska, due to the fact that it has to be taken from a distance to the more remote communities away from water transportation routes, and the very general occurrence of peat beds throughout the Territory make it especially pertinent to consider briefly at this time the possibility of utilizing peat prepared by some of the simpler and cheaper methods in use in Europe.[a]

Peat is partly decomposed vegetable matter that is intermediate in character and fuel value between wood and coal. When properly prepared and air dried it burns freely and gives off more heat than the best wood, but not so much as bituminous coal of good quality.

It is of widespread occurrence in the moister parts of the earth and, in a somewhat fibrous form, covers great areas in Alaska, especially in the regions where tree growth is sparse or lacking. In this part of the world it is formed chiefly by the growth and partial decay of mosses, grasslike plants, water plants, shrubs, and more rarely trees. It develops only in places where the ground is covered by water, is very wet, or is frozen, or where the air is very moist. One of the forms of peat is the brown vegetable matter that covers the great barrens and tundras of the northern part of Alaska.

The chief difficulty in using peat for fuel is that it is always saturated with water, or nearly so, as it is found in the beds, and has to be dried before it can be burned. The drying can be done most cheaply and quickly by exposure to the wind and sun.

In northern Europe peat is used for heating and cooking by the common people, and to a considerable extent also for producing steam and for making gas for illuminating and power purposes.

[a] For a more detailed discussion of the uses of peat and the processes of preparing it, the reader is referred to Bulletin 376 of the U. S. Geological Survey, entitled "Peat deposits of Maine," and to a forthcoming bulletin on the peat deposits of the eastern Coastal Plain of the United States. These may be had by applying to the Director, U. S. Geological Survey, Washington, D. C.

For these uses it is prepared and sold as (1) cut peat; (2) machine peat, or pressed peat; (3) peat powder; (4) briquetted peat; (5) peat coke or charcoal. Peat gas is also made, either in retorts, with coke or charcoal and various chemical substances as by-products, or in the gas producer, in which the peat is all converted into a low-grade fuel gas, called "producer gas." This gas may be used for power production, by burning under boilers or, more economically and with greater efficiency, in gas engines of the explosive type. Used in this way, peat is a better fuel than the best grades of bituminous coal burned under steam boilers of the ordinary types.

Peat is also used extensively in Europe and to a less degree in the eastern United States as stock bedding, for which it is especially adapted. It is also used in the manufacture of chemical fertilizers as a filler.

As peat is successfully prepared and used for fuel as far north as 66° 39′ north latitude in Sweden, and in Iceland, where the season is very short and the air very moist, there seems to be no reason why it should not be used in Alaska, in places where other fuel is costly, even if labor is high. In the expectation that the great stores of fuel in the peat beds of Alaska may be used to some extent, the following brief statement of simple ways of preparing the peat for use is given.

Cut peat is made by cutting out the denser layers of peat beds with spades. The part of the bog to be used is drained, if necessary, by ditches from 30 to 50 feet apart and 1 foot wide. The peat is cut from a working trench started at right angles to and at the head of the ditches. The cutting is done with sharp, straight, narrow spades in regular courses, which are as wide as the bricks are long and as thick as the length of the spade will permit. The courses are further divided by horizontal cuts which regulate the thickness of the bricks. The size of the bricks depends on the readiness with which the peat dries and its density. Small bricks should be made if the climate is moist and the peat dense. In Europe the bricks are cut from a foot to a foot and a half long and from 4 to 6 inches wide and thick. In some localities the spade used for cutting has a narrow steel lug welded at right angles to the point, so that two sides of a brick can be cut at once.

As fast as the bricks are cut they are laid on the surface of the ground near the opening, where they are left for one or two weeks until dry enough to handle. They are then stood on end in groups of six or seven, with two others laid crosswise on the top of the pile. At the end of another two weeks, more or less, the bricks are turned and piled into larger heaps, being laid up in crib or cob fashion. They may be left in these piles until dry, or after a time piled into open stacks, the tops of which should be covered with turf or other covering that will shed water, as the bricks are very absorbent. The only tools needed

for making fuel by this method are sharp, strong spades, or strong, long-bladed knives. Coarse and poorly decomposed peat is not very satisfactory fuel when prepared in this way. In Europe the diggers are paid by the thousand pieces cut and laid out, and in the same way for turning and drying. The cost per ton for the production of air-dried bricks varies from as low as 53 cents to $1.75, according to the kind of peat cut, the wages paid, and the efficiency of the men.

Another form of peat fuel is machine peat, also known as pressed or condensed peat. Coarse, fibrous peat makes a better fuel when it is reduced to a pulp by grinding it with the addition of water, and afterward shaping it into bricks and drying it as for cut peat. The grinding may be done by throwing the peat into a hole in the bog, mixing with water, and trampling it until the mass is reduced to a thick porridge. Instead of the hole, a box or trough of wood or metal may be used, and the trampling may be done by a horse. Sometimes a shaft armed with knives, curved screw-fashion, is placed lengthwise in the box, and by means of simple mechanical gearing is turned by horsepower. The peat must be made very wet to be successfully ground in this form of machine and the trough must be at least 15 feet in length.

After the peat is reduced to a thin, fine pulp it is removed in barrows and spread out on the cleared and smoothed surface of the peat bed, in a layer 6 to 8 inches thick, and marked off into bricks of the desired size with a knife or by hand. The bricks soon become dry enough to handle, shrinking apart as drying goes on, and may then be treated in the same way as the cut bricks.

A more modern way of making this product is with a peat machine, which is, in effect, an iron cylinder, with a hopper for receiving the peat at one end and a square nozzle for shaping the peat into a prismatic strand as it is pressed out at the other. Inside the cylinder is a revolving, knife-armed shaft, with the knives curved to form a screw, as in a brickmaker's pug mill or in some of the meat grinders so commonly used. The bricks are formed as the wet peat is forced from the nozzle. Such machines are made in all sizes, from one requiring a single horse for motive power and turning out from 3 to 5 tons of peat fuel a day (air-dry weight) to those run by powerful steam engines and making 50,000 or more bricks a day.

Machine peat, in whatever way it is prepared, is more compact and more easily handled, breaks up less readily, and dries more quickly and thoroughly than cut peat and is nearly waterproof after the outside is once dry. The cost of making it in Europe varies from 85 cents to $2 a ton, but is generally about $1 a ton.

The other processes mentioned for preparing peat for fuel are probably not adapted to conditions existing in Alaska, although peat

might be used as a source of producer gas in many localities where electric or other power is required, as in mining operations. For use in the gas producer, the peat should be machined and at least partly dried.

The amount of fuel in a peat deposit may be roughly estimated by finding the area in acres and average depth in feet, and multiplying the product of the two by 200, the number of tons of air-dry fuel which can be made from an acre of peat 1 foot in depth.

The proper time to make peat fuel is in the early part of the spring and summer, the season running from the middle or last of April until early September. If frozen while wet, the bricks are very spongy and fall to pieces readily.

If peat is to make good fuel, it must be dried clear through to the air-dry state; when it is in this condition it burns with a clear, bright, long, nearly smokeless flame and gives out a strong and lasting heat; if it smoulders and requires much draft to keep it afire, it has not been properly dried, for dry peat burns in a common stove with but a very slight draft, and a fire once started in it will not go out until the last bit of the fuel is gone, even if the draft is cut off entirely. Early cutting, thorough drying, and some protection from the heavy rains are the chief secrets of success in making and using this material for fuel.

Peat litter for bedding horses is made by drying and pressing into bales the more fibrous kinds of peat. A bed of this material 6 inches thick will last for months and is greatly superior in springiness and absorbent qualities to the best hay or straw. The moss growing on the top of many of the peat beds, when dried, is a good material for packing all perishable articles of food, as it is strongly antiseptic and serves also as a protection against freezing and breakage.