INVESTIGATION OF MINERAL RESOURCES OF ALASKA IN 1909.

By ALFRED H. BROOKS and others.

ADMINISTRATIVE REPORT.

By ALFRED H. BROOKS.

PREFACE.

It has become an established practice of the Geological Survey to issue each year a bulletin in which both the conditions of the mining industry of Alaska and the more important economic results obtained by the investigations during the year are summarized. This volume, the sixth of this series, is, like those previously issued,[a] intended to serve as a handbook of reference for those who are interested in the mining and mineral resources of the Territory. None of the various papers here included represents final results; they simply outline the general features of the geology and mineral resources of the areas discussed, special emphasis being laid on conclusions that may have an immediate practical bearing on the development of the mining industry.

The rapid progress in prospecting and mining in Alaska makes it necessary to publish the results of geologic surveys as soon as possible, that they may become available to the prospector, mine operator, and engineer. In publishing such preliminary results there is, of course, danger that more exhaustive investigation may show some of the conclusions to be at fault. Those interested in any particular district are, therefore, advised to obtain the complete reports, which are illustrated with maps, photographs, and diagrams, as soon as they are available. It is to be regretted that the publication of the complete reports is usually delayed because of the time required by the laboratory and office work necessary for their preparation and by the elaborate illustrations. Moreover, it frequently happens that,

[a] Report on progress of investigations of the mineral resources of Alaska, 1904: Bull. U. S. Geol. Survey No. 259, 1905. Idem, 1905: Bull. 284, 1906. Idem, 1906: Bull. 314, 1907. Idem, 1907: Bull. 345, 1908. Idem, 1908: Bull. 379, 1909.

after the completion of the office work on the results of the survey of an area, a reexamination in detail of part of the district is necessary. Such a reexamination delays the completion of the report, but is fully justified because of the desirability of making the publications as complete statements of the facts and their interpretation as the character of the survey, the conditions of the region, and the progress of the science of applied geology will permit.

This volume is arranged on the same plan as those previously published. First will be presented a general account of the mining industry of Alaska in 1909, which includes the statistical data. This will be followed by nineteen special papers contributed by seventeen authors, which fall into two classes. One class includes the papers of a general character summarizing the mining progress of certain of the most important districts, and these have been prepared by the geologists or engineers who are most familiar with the districts. The other class of papers comprises those that present preliminary accounts of the results of surveys and investigations and are, in fact, progress reports, which will be supplanted by the more complete accounts to be published later.

The summary of the mining conditions throughout the Territory is based on the best information available and is made as complete as possible. For the districts that have been visited during the year by a representative of the Survey, definite information is at hand. It is impossible, however, with the small force available, to visit all parts of the Territory every year. Therefore it is necessary to supplement the information gathered by members of the Survey by data obtained from various sources. As in previous years, the writer has had the cordial cooperation of many Alaskans in the collection of such data. It would be impossible to enumerate all those who have contributed to this work. They include mine operators, territorial officials, officers of banks, transportation companies, and other corporations, as well as many prospectors. Special acknowledgment should, however, be made to the following, some of whom have furnished not only data used for statistical purposes, but also statements on the progress of mining, etc.: James H. Watson, of Valdez; A. K. Beatson, of Latouche; W. H. Hammer, of Sunrise; C. E. Cone, of Knik; R. Blix, of Copper Center; George W. Esterly, of Nizina; Milin Dempsey, of Dempsey; E. R. Brady, of Jack Wade; J. H. Van Zandt, of Fortymile; J. J. Hillard, of Eagle; Ralph Donaldson, of Rampart; V. L. Bevington, of Hot Springs; J. C. Dillow, Falcon Joslin, Fairbanks Banking Company, First National Bank, Washington-Alaska Bank, and Alaska Pacific Express Company, of Fairbanks; E. R. Stevens and R. T. Hirsh, of Nome; C. W. Thornton, of Solomon; Lewis Lloyd, of Shungnak; and G. C. Cole, of Dawson.

As in previous reports, much attention is given in this volume to the consideration of the gold-placer districts, for placer mining is still the dominating industry of the Territory. In contrast with the previous bulletins, however, more space is here devoted to new fields of possible mineral value. Of this character are reports discussing the mineral resources of the eastern part of Kenai Peninsula, of the Iliamna and Clark lakes region, and of the Norton Bay region. The investigations of these areas have been made possible by the fact that some surveys in more important mining districts are nearing completion, and hence during 1909 a much larger percentage of the funds available could be devoted to reconnaissance and exploratory work. An important feature of the volume is the presentation of the new data obtained by a resurvey of the Koyukuk and Chandalar placer districts. Probably the most important contribution is the paper on the occurrence of auriferous quartz in the Fairbanks region.

The work has embraced investigations of a varied character and has been widely distributed throughout the Territory. Reconnaissance, detailed geologic and topographic surveys, and explorations have been made along with special investigations of the gold, copper, and coal deposits. Data have been obtained on stream flow in the placer and lode districts, some general stratigraphic and geologic studies have been made, and statistics of mineral production have been collected, as well as data on the progress of mining.

Fourteen parties, including 23 technical men and about 30 packers, cooks, etc., have been engaged in Alaskan surveys and investigations during the season of 1909. In addition, some gage readers were employed, who gave only a part of their time to the work. Of the technical men, 12 were geologists, 7 topographers, and 4 engineers. The length of field season for these different parties has varied greatly, but the work was carried on between March and November. Three parties were engaged in geologic work, five in both topographic and geologic surveys, two in topographic surveys, and four in investigating water resources.

The areas covered by geologic explorations (10 or 16 miles to the inch) amount to 6,100 square miles; by geologic reconnaissance surveys (4 miles to the inch), 5,500 square miles; by detailed geologic surveys (1 mile to the inch), 453 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the important mining districts, the results of which can not be presented areally. Some 6,190 square miles of topographic exploratory surveys (10 or 16 miles to the inch), 5,170 square miles of topographic reconnaissance surveys (4 miles to the inch), and 444 square miles of detailed topographic surveys (1 mile to the inch) were completed.

In the Yukon-Tanana region 21 gaging stations have been maintained during the year, furnishing data on the water resources of about 3,000 square miles. In the Seward Peninsula 60 gaging stations have been maintained, yielding data on some 3,600 square miles.

To state the work geographically, three parties were in southeastern Alaska, one in the Copper River basin, one on Prince William Sound and Kenai Peninsula, one in the Matanuska Valley, two in the Iliamna Lake region, three in the Yukon basin, and three in the Seward Peninsula and Norton Bay region.

Among the important results of the year have been the completion of a detailed base map of the most important part of the Matanuska coal field; the completion of a detailed geologic survey of the eastern part of the Chitina copper-bearing belt; and the exploration and survey of large areas in the Iliamna Lake, Norton Bay, and Kenai Peninsula regions. The study of the Berners Bay gold district has been completed. Much new information on the general geology and mineral resources of the Yukon-Tanana region has been obtained, especially regarding the Fairbanks district. The stream-gaging work in the Seward Peninsula and Yukon-Tanana regions has yielded important results on the water available for placer mining.

The following table shows the allotment, including both field and office expenses, of the total appropriation of $90,000 to the various districts investigated:

Allotment to Alaskan surveys and investigations in 1909.

Southeastern Alaska	$10,700
Copper River region	8,200
Kenai Peninsula, Iliamna Lake, and Alaska Peninsula regions	27,950
Matanuska region	10,900
Yukon basin	18,850
Northwestern Alaska, including Seward Peninsula	13,400
	90,000

The Alaskan surveys, both geologic and topographic, can be conveniently classed in three grades, in accordance with the refinement with which the field work is carried on, namely, exploratory, reconnaissance, and detailed. What are here termed exploratory surveys embrace all those which yield only very general information as regards topography and geology. Horizontal location in this work is often based purely on foot traverses, and vertical control on aneroid barometer readings. Such work, while it has no permanent value, affords a means of obtaining a general knowledge of the larger geologic and topographic features of a region at a low cost. It also, as a rule, yields sufficiently accurate data regarding mineral resources to make it possible to decide whether a more expensive investigation is justified. The maps resulting from such surveys, which are published on a scale of 10 or 16 miles to the inch, have no geodetic value, but are usually

accurate enough to guide the occasional prospector and traveler. Where relief is shown by contours the interval is usually 500 or 1,000 feet. Most of the surveys made during the first few years after the Alaskan surveys were begun were of this type. By this means a skeleton of explorations was extended over much of the Territory, which yielded some information with regard to very extensive areas.

The reconnaissance topographic surveys are all based on mensuration accurate to the scale. Both horizontal and vertical control are based on careful instrumental work. It is true, however, that the positions of the resulting maps are sometimes not accurately fixed, owing to the absence of a systematic triangulation scheme. The error in position is, however, usually not sufficient to affect the value of the map for anything but geodetic purposes.

The geologic reconnaissance surveys vary in degree of refinement. Usually they are based on an amount of field work which does not admit of more than a very broad basis of stratigraphic classification. So far as circumstances permit, the attempt is made to keep the field mapping accurate to the scale.

All the geologic and topographic reconnaissance maps are published on a scale of 4 miles to the inch (1:250,000). The contour interval chosen is generally 200 feet.

Detailed topographic maps have been prepared of only a few of the most important mining districts. These have all been published on a scale of 1 mile to the inch (1:62,500), with 25, 50, or 100 foot contours. While these detailed maps are thoroughly controlled within themselves as to vertical and horizontal position, yet in those made of areas lying away from tide water the contours are not always referable to a bench mark, the altitude of which is definitely fixed. The same is true also of the horizontal control. Although the geodetic value of the maps is thus impaired, the defects do not curtail their usefulness for engineering purposes.

The detailed geologic maps that have been published are accurate to the scale. Some of them have not gone into so great a degree of refinement in stratigraphic units as the Survey's maps of better-settled districts than Alaska. This is not, however, because the Alaskan geologist has lower standards than he who works in the States, but because the degree of mining development in the Territory, as a rule, does not warrant the expenditure of the additional money which would be necessary to accomplish these great refinements.

In the following table the approximate amount of money devoted to the investigations of each class is indicated. It is not possible always to give the exact figures, as in some cases the same party or even the same man has carried on two different kinds of work; but this statement will help to elucidate a later table which will summarize the complete areal surveys.

Approximate allotment of Alaskan funds to different kinds of surveys and investigations in 1909.

Geologic reconnaissance and exploratory surveys	$31,800
Detailed geologic surveys	9,200
Special geologic investigations	2,500
Topographic reconnaissance and exploratory surveys	11,500
Detailed topographic surveys	15,000
Investigations of water resources	8,300
Collection of statistics of mineral production	1,500
Miscellaneous, including clerical salaries, administration, inspection, instruments, and office supplies and equipment	10,200
	90,000

Allotment for salaries and field expenses, 1909.

Scientific and technical salaries	$30,720
Field expenses, equipment, and supplies	50,660
Clerical and other office salaries	8,620
	90,000

The following table exhibits the progress of the Alaska investigations and the annual grant of funds since systematic surveys began in 1898. It should be noted that since 1902 a part of the money has each year been spent on special investigations of mineral deposits, the results of which can not be expressed areally.

Progress of surveys in Alaska, 1898–1909.[a]

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[b]					Water-resources investigations.	
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	Gaging stations maintained part of year.	Stream volume measurements.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*			
1898	$46,189.60	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....	.....
1899	25,000.00	6,000	.....	.....	8,690	.....	.....	.....	.....	.....	.....
1900	60,000.00	3,300	6,700	.....	630	11,150	.....	.....	.....	.....	.....
1901	60,000.00	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....	.....
1902	60,000.00	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....	.....
1903	60,000.00	5,000	8,000	96	.....	15,000	.....	.....	.....	.....	.....
1904	60,000.00	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000.00	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000.00	5,000	4,000	421	.....	13,500	40	.....	.....	14	286
1907	80,000.00	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000.00	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000.00	6,100	5,500	450	6,190	5,170	444	.....	.....	81	703
	781,189.60	60,700	51,900	2,549	47,680	85,770	2,775	459	72	.....	.....
Percentage of total area of Alaska		10.35	8.89	0.44	8.16	14.63	0.47	.....	.....	.....	.....

[a] The areas presented in this table differ somewhat from those previously published. This is due in part to the reclassification of the work and in part to the fact that the areas have been more carefully scaled from the maps than formerly.

[b] In addition to the above, the International Boundary Survey and the Coast and Geodetic Survey have made surveys of parts of Alaska.

The exploratory and reconnaissance geologic surveys have covered an area of 112,000 square miles, equal to about 19 per cent of the total area of Alaska. This work has, however, been so distributed as to indicate something of the general geology of at least two-thirds of the Territory. The exploratory and reconnaissance topographic surveys aggregate 133,450 square miles, or about 23 per cent of the total area. Although nearly four-fifths of the Territory is still unsurveyed, yet all the larger geographic features have been blocked out by a system of explorations and reconnaissances. All but two[a] of the larger rivers have been surveyed. In spite of this progress, there is still at least 100,000 square miles of which geologic and topographic maps are urgently needed.

Detailed surveys have only just been well begun, less than one-half of 1 per cent of the total area having been covered. It will be necessary, however, to survey in detail only the important mining districts, and about 50 per cent of those now known have been covered, but, naturally, with the advance of the mining industry other districts will have to be included in the plans for detailed survey.

GEOGRAPHIC DISTRIBUTION OF INVESTIGATIONS.

GENERAL WORK.

The writer left Seattle for Cordova on July 1, 1909, and, going inland over the Copper River route, reached Mr. Moffit's camp (see p. 15), in the Nizina region, on July 17. About two weeks were spent with Mr. Moffit and Mr. Capps in visiting some of the mineral deposits of the district and in studying the areal geology. On July 24, in company with Mr. O. Potter, a mining engineer from Houghton, Mich., the writer went overland from the Nizina region to the Copper River crossing, and thence to Tonsina, on the Valdez-Fairbanks trail. Mr. Potter's intimate knowledge of this region made his companionship of great value and mitigated to a certain extent the disagreeableness of traveling on foot through a little-inhabited region during almost continuous rainstorms. From Tonsina Mr. Potter went to Valdez, and the writer traveled inland over the military trail to Fairbanks, which he reached on August 19. Here he met the Prindle party (see p. 15) and spent some days in visiting a few of the more important lode prospects of the district. Later he returned to the coast by way of the White Pass and Yukon route. A week was spent during September in visiting Mr. Bagley and Mr. Knopf in their survey of the Eagle River district.

In the office the writer has given most of his time to administrative and routine work, in which he was aided by R. H. Sargent, who super-

[a] The Noatak and Colville. An exploration of the Noatak has been made by the Revenue-Cutter Service; the lower Colville has been mapped by the Geological Survey, and its headwaters have been explored by navy officers.

vised the topographic surveys. By order of the Director and in cooperation with Mr. Sargent comprehensive plans for subdivisional surveys of the agricultural and coal lands of Alaska were made and submitted to the Secretary of the Interior.

During the writer's absence in the field E. M. Aten looked after the office routine and also rendered valuable service in the compilation of mineral statistics of Alaska. The little time available for routine duties was devoted by the writer to a continuation of the work on the Mount McKinley report. Some progress was also made in the collection of data for the preparation of a summary report on the mineral resources of Alaska.

W. W. Atwood has, in addition to his work in southwestern Alaska (see p. 18), done some work on a report which will summarize the knowledge of the stratigraphy of the more important coal-bearing rocks of Alaska. The interest in the peat deposits of Alaska awakened by a brief paper on the utilization of this fuel,[a] which was published last year, seemed to justify a more complete account of the processes involved. Mr. Davis, who is the recognized authority on this subject, has kindly prepared another paper which appears on pages 101–132 of this volume.

In addition to working up the topographic field data, the office force has also devoted some attention to the compilation of special maps. There is a large demand for general maps which shall cover several mining districts. This demand is being met by compiling maps for publication on a scale of 8 miles (1:500,000) or 16 miles (1:1,000,000) to the inch. One such map (scale 1:500,000, with 200-foot contours) of Seward Peninsula and another of the Koyukuk and Chandalar placer districts have been compiled. It is planned to prepare similar maps of all the most important mining regions of Alaska as fast as circumstances permit and the field data become available. These compilations are being made under the direction of Mr. Sargent.

SOUTHEASTERN ALASKA.

Adolph Knopf began the study of the geology and mineral resources of the Berners Bay region on May 25 and completed it about a month later. He devoted the rest of the season to carrying similar investigations southeastward along the mineralized belt which connects the Juneau and Berners Bay mining districts. These investigations were carried southward to Eagle River, leaving an unmapped area, the work on which will be completed in 1910. A total area of 125 square miles was mapped by Mr. Knopf.

In the Berners Bay region Mr. Knopf was hampered in his economic studies by the fact that all the mines were closed. It was therefore

[a] Davis, C. A., The possible use of peat fuel in Alaska: Bull. U. S. Geol. Survey No. 379, 1909, pp. 63–66.

impossible to make the exhaustive studies which the importance of the district warrants. In the fall about ten days was devoted by Mr. Knopf to visiting the fields of the most important mining developments, and the results of these investigations are embodied in a report in this volume. (See pp. 133–163.) Mr. Knopf's report on the Berners Bay region has been submitted for publication.

It is to be regretted that the Geological Survey is not able to offer salaries sufficient to hold some mining geologists in the service. For this reason the report of C. W. Wright on the copper deposits of Kasaan Peninsula and Hetta Inlet is still incomplete. Mr. Wright had offers for professional services in Sardinia which he could not afford to refuse, and hence left the Survey before his report was completed. It is expected, however, that he will finish the report this summer.

J. W. Bagley, assisted by R. E. Johnson, began topographic work in the Eagle River district on May 15 and continued, so far as weather conditions permitted, until October 22. In spite of the exceptionally wet season, an area of 154 square miles was mapped for publication on a scale of 1 mile to the inch, with 50-foot contours. The almost continuous rain or cloudy weather and the heavy timber and underbrush made the detailed survey of this area one of extraordinary difficulty and expense. There still remains about 20 or 30 square miles to survey to connect this area with the region covered by the Juneau special map, and this work will be undertaken in 1910.

KENAI PENINSULA.

The gold placers and coal resources of the Kenai Peninsula were investigated by the Geological Survey in 1904, since when the demands for work in other parts of the Territory had prevented further surveys in this district. Meanwhile, as some promising lode deposits had been opened up, the need for further investigation had become more pressing. Therefore U. S. Grant and D. F. Higgins were engaged to extend the reconnaissance surveys in this field.

The party was employed from June 10 to July 9 in supplementing and completing the reconnaissance of Prince William Sound, and from July 9 to September 10 in making a rough topographic survey and geologic investigation of the eastern and southern coast of Kenai Peninsula from Seward to Seldovia. A boat traverse of the shore line was made, and the topography was sketched for 1 to 3 miles inland. Short trips were also made to Moose Pass and False Creek, north of Seward. In all an area of about 600 square miles was covered by the geologic and topographic survey. A brief summary of the economic results of this investigation is presented in this volume (pp. 166–178) and the more complete report is in preparation.

ILIAMNA AND CLARK LAKES REGION.

One of the largest regions of southern Alaska that was unsurveyed previous to 1909 lies west of Cook Inlet, including the drainage basins of Iliamna and Clark lakes. The presence of copper and gold deposits in this region has been reported, and a survey was determined upon as part of the general plan to extend the reconnaissance work in new fields so far as circumstances permit.

The field work in this region was a combined topographic and geologic reconnaissance by a party of twelve men in charge of D. C. Witherspoon, topographer. The party landed and began work at Iliamna Bay May 16, 1909. After crossing the mountains to Iliamna village it was divided into two sections. One of these, in charge of Mr. Witherspoon, with F. J. Katz, geologist, consisted of six men and was equipped with a pack train of eight horses. This party traversed the area north of Iliamna and east of Clark Lake. The other party, in charge of G. C. Martin, geologist, with C. E. Griffin as topographer, likewise consisted of six men and was equipped with three Peterboro canoes. This party traversed the shore lines of Iliamna and Clark lakes, mapping as much of the topography and geology as could be reached from the shore, and made an exploratory trip down Kvichak River to Kogiung. Field work for both parties ended at Iliamna Bay on September 28. The topographic surveys of these two parties covered an area of 5,150 square miles, the geologic surveys 3,000 square miles. A brief summary of results is included in this volume (pp. 179–202).

MATANUSKA VALLEY.

In accordance with the established policy of surveying the more valuable coal fields in detail as soon as circumstances permit, the preparation of the base map of the Matanuska field was undertaken this year. This survey was made by R. H. Sargent, assisted by J. B. Leavitt, who were occupied in it from June 11 to September 18. During this time an area of 196 square miles was covered for publication on a scale of 1 mile to the inch (1:62,500) with 50-foot contours.

COPPER RIVER REGION.

The completion in 1908 of the reconnaissance surveys [a] of the two copper belts lying north and south of the Wrangell Mountains paved the way for more detailed investigations. As the southern or Chitina copper belt will be the first one to be developed, it was

[a] Moffit, F. H., and Maddren, A. G., The mineral resources of the Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909.

Moffit, F. H., and Knopf, Adolph, The mineral resources of the Nabesna-White River district, Alaska: Bull. U. S. Geol. Survey No. 417, 1910.

appropriate to begin the detailed investigation in this field. The funds available for this work made it possible to survey only a part of the Chitina belt, and after careful consideration it was decided to take up the work in the Nizina district first. This conclusion was based on three considerations. (1) The information available indicated that the Nizina district afforded the best opportunities for solving the general geologic problems relating to the entire copper belt. (2) The mining developments of this part of the district were more extensive than elsewhere in the belt and thus gave better opportunities for observations on the occurrence of the ores and greater promise of soon reaching a productive basis. (3) Investigation of this field made it possible also to cover the Nizina placer district, which had long been productive in a small way and gave promise of a larger output.

A topographic base map of the Nizina district was made by D. C. Witherspoon in 1908, and F. H. Moffit and S. R. Capps devoted the time from July 2 to September 10, 1909, to a detailed study of its geology and mineral resources. During this time an area of 325 square miles was surveyed. This investigation covered only about one-quarter of the Chitina copper belt, but it is believed that the conclusions reached as to the occurrence of the ores will have value to the entire district. If the developments in the Chitina Valley continue, as is anticipated, further detailed surveys should be undertaken.

YUKON-TANANA REGION.

L. M. Prindle, assisted by B. L. Johnson, continued the geologic mapping in the Yukon-Tanana region, devoting special attention to the study of the auriferous quartz veins in the vicinity of Fairbanks. A preliminary statement of the results of this later study is presented on pages 230–245 of this report. The geologic mapping of some 2,000 square miles was completed, which practically finishes the reconnaissance work in that part of the Fairbanks quadrangle lying north of the Tanana. A final report on this work is in preparation, an abstract being presented on pages 203–229 of this volume.

Water-resources investigations were continued in the Fairbanks and Circle districts during 1909 by C. E. Ellsworth. Mr. Ellsworth began stream gaging at Fairbanks on April 20 and continued his measurements until September 10. Twenty-one gaging stations and four rainfall stations were maintained and 232 measurements were made. These investigations furnished information regarding the run-off of about 3,000 square miles. A brief statement of results is contained on pages 251–283 of this bulletin. It will take several years more of observations before the average run-off of the various streams can be even approximately determined.

KOYUKUK AND CHANDALAR DISTRICTS.

Reconnaissance surveys were made of the Koyukuk and Chandalar placer districts by F. C. Schrader and T. G. Gerdine in 1899. As there has been much progress in mining in this field, a reexamination and an extension of the surveys were undertaken as a part of the plans for 1909. The work was intrusted to A. G. Maddren, who, with one man and two horses, went from Fort Hamlin, on the Yukon, northward to Coldfoot, on the Koyukuk. After investigating the placer deposits in the vicinity of Coldfoot, he continued his journey to the Chandalar district and thence returned to the Yukon. The field work continued from June 25 to September 4, during which about 500 square miles were surveyed geologically and topographically and practically all the important placer localities were visited. A summary of the results is published in this volume (pp. 284–315), and the more complete report is in preparation.

NORTON BAY REGION.

Previous to 1909 one of the largest unsurveyed areas of the more accessible parts of Alaska was one which lies between the lower part of the Koyukuk and the Yukon at Nulato and Seward Peninsula. The exploration of a part of this field was undertaken last summer by P. S. Smith and H. M. Eakin. The party, including packer and cook, with four horses, left Nulato on June 26 and reached the mouth of the Koyuk, to which some supplies had been sent from Nome, about three weeks later. The following month the surveys were continued to the northeast and to the south, and later the work was carried westward across the Fish River basin, ending at Council September 22. The results included a rough exploratory survey of about 5,000 square miles and a somewhat more detailed survey of 200 or 300 square miles.

SEWARD PENINSULA.

Stream gaging was continued in Seward Peninsula during the summer of 1909 by F. F. Henshaw and G. L. Parker. The field work began near Nome on June 12 and was continued in the various mining districts of the peninsula until September 22. A brief summary of results is presented on pages 372–418 of this report. Mr. Henshaw is also engaged in preparing a summary report on the results of the stream gaging which has been done in Seward Peninsula during the past four years.

COLLECTION OF STATISTICS.

As in previous years, the statistics of the gold, silver, and copper production of Alaska were collected by the writer, assisted by various members of the field force and by Mr. Aten. Every year a larger percentage of the operators show their interest in this work by fur-

nishing data of production. If funds were available for sending a representative into each district to collect the required information in person, complete and reliable figures could undoubtedly be had. As it is, the work is still largely done by correspondence, and the address list of operators is by no means complete. It is expected, however, that soon every operator in the Territory will report his production, so that accurate totals for each district can be published. Until this is done the figures of production can be only approximate. The attention of all those interested in the advancement of the mining industry of Alaska is directed to the fact that it will be greatly to the advantage of this industry if accurate figures of the gold output of each district are published. Those operators who have hesitated to furnish the desired information for fear it might be used to their disadvantage are reminded of the fact that the Geological Survey has received confidential information from practically every mining corporation in the States for many years and has never been charged with betraying a confidence. The figures furnished are used only to make up totals of districts, and every precaution is taken to prevent their being published in any way to indicate the output of individuals or corporations unless permission has been explicitly granted in writing. Reports are now received from nearly every lode mine in Alaska, but there is still a large percentage of the placer miners who neglect to return the schedules mailed to them. Fortunately there are other, though less exact, sources of information. The statement of placer-gold production as presented is, then, based in part on the returns from operators and in part on data furnished by bankers, express companies, federal officials, and other residents of Alaska.

PUBLICATIONS ISSUED OR IN PREPARATION.

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 1909 the Survey published three bulletins, one professional paper, one water-supply paper, and three separate maps relating to Alaska. Two other bulletins appeared in the early part of 1910. The complete list is as follows:

REPORTS.

Mineral resources of Alaska; report on progress of investigations in 1908, by Alfred H. Brooks and others. Bulletin 379.

The Yakutat Bay region, Alaska; Physiography and glacial geology, by R. S. Tarr; areal geology, by R. S. Tarr and B. S. Butler. Professional Paper 64.

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

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

Water-supply investigations in the Yukon-Tanana region, Alaska, 1907 and 1908, by C. C. Covert and C. E. Ellsworth. Water-Supply Paper 228.

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

The Nabesna-White River copper region, by F. H. Moffit and Adolph Knopf; including geologic and topographic reconnaissance maps. Bulletin 417.

MAPS ISSUED SEPARATELY.[a]

Index map of Alaska showing areas surveyed and published sheets; also includes a list of recent publications.

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

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

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 1910:

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.

Geology and mineral resources of the Berners Bay region, Alaska, by Adolph Knopf, including detailed topographic and geologic maps.

The Yakutat Bay earthquake of September, 1899, by R. S. Tarr and Lawrence Martin. Professional Paper 69.

Geology and mineral resources of the Nizina district, Alaska, by F. H. Moffit and S. R. Capps, including detailed geologic and topographic map.

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

The Mount McKinley region, by Alfred H. Brooks and L. M. Prindle, including geologic and topographic reconnaissance maps. Professional Paper 70.

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 topographic and geologic maps.

The Fairbanks quadrangle, by L. M. Prindle, including geologic and topographic reconnaissance maps.

The Koyukuk and Chandalar placer districts, by A. G. Maddren, including geologic and topographic reconnaissance maps.

Geologic reconnaissance in southeastern Seward Peninsula and Norton Bay-Nulato region, by P. S. Smith and H. M. Eakin.

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

Geology and mineral resources of the Solomon and Casadepaga quadrangles, by P. S. Smith, including detailed geologic map. Bulletin 433.

The water supply of Seward Peninsula, by F. F. Henshaw.

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

Kasaan special map, Prince of Wales Island, scale 1: 62,500, contour interval 50 feet. Topography by R. H. Sargent, J. W. Bagley, and D. C. Witherspoon.

Copper Mountain special map, Prince of Wales Island, scale 1: 62,500, contour interval 50 feet. Topography by R. H. Sargent.

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

Map of Circle quadrangle, scale 1: 250,000, contour interval 200 feet. Topography by D. C. Witherspoon.

Map of Fortymile quadrangle (new edition), scale 1: 250,000, contour interval 200 feet. Topography by E. C. Barnard.

Map of Seward Peninsula, scale 1: 500,000, contour interval 200 feet. Topography by United States Geological Survey.

THE MINING INDUSTRY IN 1909.

By Alfred H. Brooks.

INTRODUCTION.

Gold placer and lode mining in Alaska in 1909 showed marked progress over the previous year both in the amount of actual gold production and in the advances made in preparation for more extensive operations. The copper output was less than in 1908, chiefly because the low price of this metal did not encourage mining, but, nevertheless, considerable prospecting and dead work were accomplished. There was little change in the output of other minerals as compared with previous years except in that of coal, which showed a decline.

In strong contrast to the prosperity prevailing in most of the gold-bearing districts was the condition in the coal fields, where there was not only no industrial advance but in some cases a decided retrogression. This was caused in part by the long delay in the issuance of patents to coal lands, in part by the popular furor which has been raised against all Alaska coal claimants. As a consequence, many who have been earnestly striving to develop the coal fields have become discouraged, and it has become increasingly difficult to find the large amount of capital necessary to any coal-mining enterprise. Moreover, these conditions have affected other industries more or less dependent on the opening of the coal fields. This is notably true of copper mining and the construction of railways. In short, it may be said that while Alaska's gold mines have had the most prosperous year since 1906, many other mining enterprises have received a check, or even have retrograded. As the conditions which produced this retrogression are not inherent in the mineral resources of the Territory, there is every hope that they may soon be rectified.

There is no doubt that a serious handicap to placer mining is to be found in the present inadequate mineral-land laws. These tend to discourage the bona fide miner and prospector to the advantage of the speculator, whose principal aim is to obtain control of large areas of prospective placer ground without any serious attempt at development.

Those who are familiar with the conditions in this region, so difficult of access, realize that Alaska needs the most generous treatment from

the people of the United States and their representatives. Every effort should be made to encourage the construction of railroads and wagon roads and the opening of the coal and copper fields. Even in the most favored district the Alaska mine operators are, as a rule, working under great disadvantages as compared with those in the States. Owing to the excessive cost of transportation to inland Alaska, only the richest placers can now be exploited, and the mining of lode gold, copper, and coal is, in many localities, out of the question. The conditions which confront the average Alaskan are similar to those which prevailed in the Western States before the construction of the transcontinental railways.

Alaska is known to have great latent possibilities for the miner, but this mineral wealth has no value except as it be made accessible by railways and wagon roads, and much of it can be developed only by the investment of a large amount of capital for mine equipment. The exaggerated statements which have recently appeared in current literature as to the monetary value of these mineral resources are not only misleading as to fact, but also do harm by leading the people to believe that there is an equity of great immediate value for every citizen of the United States in the undeveloped wilds of Alaska. No one knows how many ounces of gold, pounds of copper, or tons of coal will eventually be won from this extensive territory. In the developed placer districts there is, to be sure, some basis for estimating gold reserves, and the surveyed portions of the coal fields give more definite results. (See p. 52.) These, however, are for the most part minimum estimates and are of value chiefly to the economist in indicating possible sources of metals and fuels for the generations to come. To take such estimates and, without regard to the cost of recovering these minerals, multiply them by the present market value in the centers of population, as has been done, is far from leading to results which have the slightest value.

The gross value of the mineral output is of importance in a discussion of the industry and enables comparisons to be made of one year with another and one district with another. This gross value is far, however, from indicating the net return to the claim owner or operator. While the exploitation of bonanza deposits of gold and copper often yields extraordinary profits, yet in the average enterprise the difference between the cost of extraction of the metal and its value is by no means excessive, considering the uncertainties of this kind of mining. In fact, it is an open question whether a large part of the gold mining of the world has not been done at an actual economic loss. The average profit on bituminous coal mining in the United States is about 10 cents a ton, and although the profit to the Alaska coal operator will undoubtedly be larger eventually, yet competition with other developed fields will prevent its becoming excessive. (See pp. 88–93.)

In spite of the fact that in 1909 the output of the Seward Peninsula placers decreased nearly 20 per cent and that of the copper mines about 8 per cent, as compared with the previous year, the value of the total mineral production of Alaska in 1909 is estimated at $21,237,502, while in 1908 it was $20,142,272. In the following table the sources of this wealth, as well as a comparison with the previous year, are presented. It should be noted that the statistics for the gold output are not yet complete and that the figures for the production of coal, gypsum, etc., during 1909 are only estimated.

Mineral production of Alaska, 1908 and 1909.

	1908.		1909.[a]		Increase (+) or decrease (−).	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....ounces..	933,290.07	$19,292,818	989,879.06	$20,463,000	+ 56,585.99	+$1,170,182
Silver.....do....	135,672	71,906	126,906	65,991	− 8,766	− 5,915
Copper.....pounds..	4,585,362	605,267	4,124,705	536,211	−460,657	− 69,056
Coal.....short tons..	3,107	14,810	2,800	12,300	− 307	− 2,510
Marble, gypsum, tin, and mineral water.....	.....	157,471	.....	160,000	.....	+ 2,529
	.....	20,142,272	.....	21,237,502	.....	+ 1,095,230

[a] Preliminary estimates.

NOTE.—In the above table copper is valued at 13.1 cents a pound for 1908 and at 13 cents for 1909; silver at 53 cents an ounce for 1908 and at 52 cents for 1909.

The increase in total value is about one-third from the gold placers and two-thirds from the gold lode mines. With the decrease in output of copper has also come a fall of 2 cents in its value per pound, as compared with 1908. The decrease in coal output is not significant, as coal mining is still confined to a small output of lignite for local consumption. As pointed out, the existing conditions do not encourage the development of coal mines, and Alaska's annual supply of some 100,000 tons is still brought in from a distance at an excessive cost to the consumer. The output of marble, tin, and gypsum is lumped together, as a separate listing might reveal the production of individual properties.

Value of total mineral production of Alaska, 1880–1909.

By years.				By substances.	
1880–1890.....	$4,686,714	1901.....	$7,007,398	Gold.....	$162,686,455
1891.....	916,920	1902.....	8,400,693	Silver (commercial value).....	1,184,259
1892.....	1,096,000	1903.....	8,941,614	Copper.....	4,800,014
1893.....	1,048,570	1904.....	9,567,535	Coal.....	323,189
1894.....	1,305,257	1905.....	16,478,142	Marble, gypsum, tin, etc.....	488,758
1895.....	2,386,722	1906.....	23,375,008		
1896.....	2,980,087	1907.....	20,847,055		169,482,675
1897.....	2,538,241	1908.....	20,142,272		
1898.....	2,585,575	1909.....	[a] 21,237,502		
1899.....	5,703,076				
1900.....	8,238,294		169,482,675		

[a] Preliminary estimate.

The increased lode-gold production came entirely from the Juneau district, though much attention was given to the prospecting of quartz claims in many other districts, notably near the town of Seward, in the Willow Creek basin, and at Fairbanks. Copper mining was continued in the Ketchikan district, where one new mine became a producer in 1909, and on Prince William Sound, while there was much activity shown in the as yet unproductive districts of Copper River. As already stated, the coal-mining industry, if anything, retrograded as compared with 1908. The output of marble and gypsum for 1909 is not yet known, but certainly was no less than in 1908.

All the placer camps except those of Seward Peninsula, where dry weather and other conditions interfered with mining (see pp. 335-354), were prosperous. In the Yukon basin there was a notable increase in the gold output of practically all the placer districts, which more than made up for the decreased production of the Seward Peninsula mines. (See pp. 43-45.) The general movement of prospectors into the Innoko basin and the adjacent parts of the Kuskokwim Valley continued during 1909.

TRANSPORTATION.

Over $17,000,000 worth of manufactured and raw material was shipped from the States to Alaska during the fiscal year ending June 30, 1909. The products returned from Alaska during the same period, including minerals, fish, furs, etc., had a value of over $30,000,000. Though no figures are available for the total tonnage represented by this commerce, these values give a measure of its importance. Transportation to and from Alaska ports is, of course, effected by steamer, at relatively low cost. Such of the supplies as are destined for points along the Pacific seaboard (open to navigation throughout the year), including a large percentage of the total tonnage, reach the consumer at relatively reasonable prices. The cost of freight to Bering Sea ports is greater, because the open season for vessels extends only from the last of May to the latter part of October. Very much heavier are the costs of transportation to inland points, reached only by river steamer in summer or long sled journeys in winter. Freight and passenger tariffs vary more or less from year to year, so that the following table will serve to guide the prospective shipper only in a general way, but is presented to indicate the approximate and relative costs of transportation:

Approximate freight and passenger rates from Seattle to towns in Alaska.

[Based on tariffs of 1907-8.]

Point of destination.	Coal, per ton.	General merchandise, per ton.	Lumber, per M.		Machinery, per ton.	Forage, per ton.		Horses, per head.	Passenger rates.	
			Rough.	Dressed.		Hay.	Grain.		First class.	Second class.
Pacific coast:										
Ketchikan	$5.00	$8.00	$7.50-$11.25	$6.50	$8.00-$22.00	$15.00	$9.00	$20.00	$22.00	$14.00
Juneau	5.00	9.00	7.50- 11.25	6.50	9.00- 23.00	15.00	9.00	20.00	25.00	16.00
Cordova, Valdez, Seward	6.00	11.00	15.00- 18.00	$10.00-13.00	11.00- 24.00	15.00	11.00	$25.00-30.00	45.00	25.00
Kodiak	8.00	14.00	18.00- 21.00	13.00-16.00	14.00- 27.00	18.00	13.00	25.00-30.00	55.00	38.00
Knik	10.00	15.00	20.00- 23.00	16.00-17.00	15.00- 28.00	19.00	16.00	25.00-30.00	55.00	38.00
Unga	10.00	17.00	20.00- 23.00	15.00-19.00	16.00- 30.00	21.00	17.00	25.00-30.00	70.00	47.00
Bering Sea coast:										
Dutch Harbor	10.00	18.00	20.00- 23.00	16.00-22.00	17.00- 31.00	22.00	18.00	30.00-35.00	90.00	60.00
Nome	12.50	15.00	18.00- 27.00	.....	15.00- 55.00	22.00	17.00	75.00	100.00	65.00
Yukon River and tributaries:										
Nulato, via Skagway	104.00	147.00	.....	.....	104.00-142.25	104.00	104.00	110.00±	115.00	90.00
Nulato, via St. Michael	.....	45.00	67.50	67.50	45.00-130.50	61.75	45.00	.....	102.00	72.00
Bettles, via Skagway	.....	.....	.....	.....	.....	.....	.....	.....	160.00	125.00
Bettles, via St. Michael	85.00	120.00	180.00	180.00	120.00-205.50	138.00	120.00	.....	150.00	125.00
Tanana, via Skagway	85.00	128.00	.....	.....	85.00-123.00	85.00	85.00	.....	106.00	81.00
Tanana, via St. Michael	.....	55.00-140.50	82.50	82.50	55.00-140.00	63.25	55.00	.....	110.00	85.65
Fairbanks, via Skagway	78.00	153.00	53.00	53.00	103.00-180.00	88.00	83.00	.....	125.00	100.00
Fairbanks, via St. Michael	73.00	73.00-146.00	109.50	109.50	73.00-104.50	83.95	73.00	.....	125.00	100.00
Rampart, via Skagway	83.00	124.00	.....	.....	83.00-120.35	83.00	83.00	.....	105.00	80.00
Rampart, via St. Michael	.....	58.00	82.50	82.50	58.00-143.50	66.70	58.00	.....	115.00	90.00
Circle, via Skagway	79.00	114.00	.....	.....	79.00-114.55	79.00	79.00	.....	94.00	75.00
Circle, via St. Michael	.....	65.00	97.50	97.50	65.00-150.50	74.75	65.00	88.00±	125.00	100.00
Eagle, via Skagway	75.00	108.00	.....	.....	75.00-108.75	75.00	.....	.....	87.00	70.00
Eagle, via St. Michael	.....	70.00	105.00	105.00	70.00-165.50	80.50	70.00	.....	130.00	105.00

It is not to be supposed that the rates given above are a measure of the total cost of transportation to the Alaska mines, for they represent only a small part of it. Along the Pacific seaboard most of the mining is confined to a zone immediately adjacent to tide water and hence there is little additional charge for transportation. Far different are the conditions in the interior, where most of the mining is 100 to 200 miles distant from the nearest point that can be reached by steamer. The data at hand are insufficient to make possible a complete statement of the cost of transportation in the various inland districts, but the following notes will indicate something of the magnitude of these charges.

Up to 1909 all the supplies for the Copper River region were sledded in winter from Valdez, and much of the freight is still carried by this route, though during the last year the railway from Cordova, supplemented by steamers on Copper River in summer and horse sleds in winter, transported a part of the supplies. The cost of transportation from Valdez varies greatly, but for points along the Fairbanks trail south of the Tanana divide it is estimated to be from $100 to $400 a ton. Winter freighting to the more distant camps, such as Valdez Creek, Chistochina, and Nabesna, costs from $500 to $700 a ton. In the past the supplies for the Chitina copper district were all moved during the winter months and were from two to three months on the way. The cost varied from $100 to $600 a ton, with an average of about $200 a ton. It should be noted that the rates quoted apply only to the winter months, when most of the freight is moved. In summer the transportation of emergency supplies by pack horses to the more distant camps costs as high as $2,000 a ton.

There is little information at hand in regard to local freight rates in the Cook Inlet and Susitna regions. It is reported that in 1909 the cost of hauling supplies by sleds from the coast to the Yentna district was $200 a ton.

In 1909 about 47,000 tons of freight was received at Nome, including merchandise, coal, lumber, and live stock, at a cost of about $660,000. The cost of freighting to the mines, by coasting vessels and wagons in summer and by sleds in winter, in different parts of Seward Peninsula varies from about $80 to $200 a ton in summer and from about $3 to $50 a ton in winter. It appears that the average price paid for transportation in the peninsula is about $20 a ton. On the assumption that half the supplies landed at Nome are for the use of the miners, this will represent an additional freight charge of nearly half a million dollars. The total transportation charge on the supplies of Seward Peninsula will, then, be about $1,200,000, or nearly 30 per cent of the value of the entire gold output of the year.

No exact figures are available in regard to the amount of freight annually shipped to the Alaska portion of the Yukon basin, but it is probably safe to say that this amounts to 30,000 tons and that it costs over $2,500,000 to land it at the end of steamboat navigation. The mine freight must then be hauled by wagons or sleds, except at Fairbanks, where there is a railway. It is estimated that this haulage from steamers to mines for the Alaska Yukon costs from $2,000,000 to $2,500,000 a year. The total annual cost of freight for the Yukon basin is, therefore, probably between $4,500,000 and $5,000,000, or nearly 50 per cent of the value of the entire gold output. It should be noted that these estimates of the cost of freight do not include any charge for the transportation of fuel, which is included in the similar figures already presented on the commerce of Seward Peninsula. In the Yukon basin practically only wood is used, whereas Seward Peninsula depends almost entirely on coal brought from a distance.

The data at hand seem to justify the conclusion that Alaska's annual expenditure for transportation of supplies and equipment is between $7,000,000 and $8,000,000. Probably 30 per cent of this represents ocean freights, which must remain a fixed charge, even with the improvement of transportation lines into the interior. It would appear that on 70 per cent of this amount a very material reduction could be brought about by the construction of railroads and wagon roads. A trunk railway into the Yukon, with a freight rate, for example, of 10 cents a ton-mile, should make a saving of at least 50 per cent in the cost of transportation of supplies and equipment to the Yukon camps. It should be noted also that, even were the freight tariffs by river and rail the same, there would be an actual money saving in shipping by rail, because of the losses entailed through the uncertainties and delays of the present system. Fairbanks freight via St. Michael is now from six weeks to two months in transit and can be transported only between about the first of July and the middle of September. Although the comparatively small amount of freight now annually carried into the Yukon basin may not seem to justify a railway, yet if a line were constructed it would give an impetus to mining that would probably soon put the enterprise on a paying basis.

The great tax on the mining industry of Alaska caused by the present system of transportation is strikingly illustrated by the fact that the annual freight bill—much, to be sure, paid indirectly—for every white man, woman, and child living in inland Alaska and on Seward Peninsula is over $350. As this figure is based on incomplete data concerning tonnage and on estimates of population it is only approximate, but it at least indicates to what order of magnitude the true figure belongs. If these estimates are correct, the amount paid

for freight in the placer camps of Alaska is equal to nearly half of the value of the annual gold production. These freight charges are reflected in the high cost of all supplies and of labor.

All of this clearly indicates why only the richest placer ground is being mined and suggests that the present industrial advancement of inland Alaska is small when compared with that which will take place when railway communication with tide water has decreased the cost of operating. While the Yukon and many of its tributaries are navigable, and parts of Copper and Susitna rivers are available for small steamers (see map, Pl. I), yet, as shown, this mode of transportation is both expensive and time consuming. It has served the purposes of the pioneer and has made possible the opening of the richer placer districts without the expenditure of the large amount of capital needed for railways. But gold and copper lode mining, not to mention coal mining, are almost impossible with only the inadequate steamboat service. Even if the rivers were open throughout the year they would be means of communication for only a small part of the mineral-bearing areas and must be supplemented by wagon roads and railways if all the mining districts are to be made productive. As it is, however, the entire water transportation has to be crowded into four months of the year.

The matter presented shows the urgent need of railways for the development of Alaska's resources, yet it can not be denied that the visible tonnage is by no means so large as to assure immediate returns on the capital invested. Present conditions are much the same as those which prevailed before the building of the transcontinental railways, though the routes chosen for the latter for the most part had the advantage over those of the Alaska railways, inasmuch as they traversed extensive areas of arable lands whose products the railways could carry to market. There is much arable land in Alaska, but the present competition with more favored fields will not justify the hope that agricultural products may be exported from the Territory, though its extensive grazing lands may eventually be a source of supply for beef. Therefore these arable lands at present will be of use to settlers only as a local market for their products arises through a population attracted by the mineral wealth. It is to the mines that the proposed railways must look for their tonnage, with every prospect that in time agricultural communities will spring up in the region made accessible. The development of coal mines will certainly yield a large tonnage, but the immediate market for Alaska coal (see pp. 80–95) is not so large as to assure the success of all the railways which are under construction or planned into the two important coal fields. There is every hope that the copper deposits will in time give business to the support of railways, but the actually developed tonnage of ore is relatively small. The latent

possibilities of the placer fields are also large, but the assured traffic for railways is by no means extensive.

These facts are here cited, not because it is intended to imply that railways can not be made a commercial success in the Territory, but simply to counteract some of the exaggerated statements in current literature of the great profits assured from railway investments. Sufficient progress has been made on several railway projects to insure that some of the coal and copper districts will be developed solely by private initiative. Whether these same railway lines will be pushed on into the little-developed placer districts without public aid is at least an open question. It seems most likely that some form of government guaranty will be necessary before a railway line from the Pacific to the Yukon will be constructed.

While many plans have been formulated for the building of railways in Alaska, most of them have not progressed very far. Interest in railway construction now largely centers in three provinces to be developed—(1) the Copper River basin and the Bering River coal field, (2) Kenai Peninsula and the Susitna and Matanuska basins, (3) the Yukon-Tanana region. Construction work is going on more or less actively in the first two, and various plans have been formulated for a railway to the third. As has been set forth at length [a] elsewhere, there are three routes of approach to the provinces above indicated. One of these extends from southeastern Alaska, at Lynn Canal, along the inland front of the St. Elias Range and the Tanana Valley. A preliminary survey has been run along a part of this route. The second line of approach is by way of the Copper River valley, where 100 miles of one railway has been completed and surveys made for several others. The third route is across Kenai Peninsula and up the Susitna and Matanuska; this line has been surveyed and about 70 miles of railway constructed. Much has been said and written about the control of these three "gateways" to Alaska and their relative value as lines of approach. In one sense they are competitive routes, but only if all three of the proposed railways are built through to the Tanana. For practical purposes, however, these lines will be noncompetitive, for it is not likely that all three will be built through so as to intersect. At least, the plea for competitive routes is not a present-day problem. What is needed is railway transportation to the Yukon basin, and then, if business develops, competitive lines may be built.

For the present a line to Copper River will develop one province; the one to the Matanuska and Susitna a second; and one of these or the line from southeastern Alaska the Tanana Valley. Within

[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. 165-190; The mining industry: Bull. U. S. Geol. Survey No. 379, 1910, pp. 23-25.

each province competition, if possible, would certainly be desirable by assuring low freight rates. It has been pointed out, however, that the visible tonnage hardly justifies the construction of one trunk line, let alone two. Nevertheless, surveys have been made for competitive lines in each of these provinces. There are three or four location surveys for railways into the Copper River basin, and many more for the development of the Bering River coal field. Competitive lines would, therefore, seem to be assured if the prospective business warrants the investment.

As stated before, actual railway construction work in 1909 was confined to two lines, namely, the Copper River and Northwestern Railway and the Alaska Northern Railway, formerly called the Alaska Central. The Copper River and Northwestern Railway [a] is a standard-gage line running from Cordova, on Prince William Sound, to Kennicott, in the Chitina Valley. The total distance is 199 miles, of which 102 miles was completed March 25, 1910. It is expected that the line will be built through to the Chitina by November, 1910. Three crossings of Copper River are made by this line, one at the head of the Delta (bridge completed), one between Childs and Miles glaciers (bridge completed), and a third at the mouth of the Chitina. The company reports that it has in contemplation the extension of the line to the Yukon basin, presumably through the pass at the head of Delta River. The distance from the crossing at the Chitina to Fairbanks is about 240 miles. The cost up to the present time has been about $10,000,000, and the estimated cost of completion is $5,000,000. Surveys have been made for a branch line from the lower Copper River crossing to the Bering River coal field. The route chosen for this branch line is 50 miles in length, with a maximum grade of 0.3 per cent, and the estimated cost is $2,000,000.

The Alaska Central Railway,[b] reorganized in 1909 under the name Alaska Northern Railway, is a standard-gage line projected from its coastal terminal at Seward, on Resurrection Bay, to Turnagain Arm, and thence to Knik, at the head of Cook Inlet (146 miles). The company reports that from this point the railway is to be extended through Broad Pass and on to Fairbanks (457 miles). From Knik a branch line (38 miles) is projected to the Matanuska coal field, with a total distance from Seward of 184 miles. These proposed routes have been surveyed. Plans for branch lines to the Kuskokwim and the Innoko have also been made, but it is not known that these lines have been surveyed yet. The distance from Knik to the Innoko district is about 270 miles. Seventy miles of the road from

[a] Data compiled chiefly from hearings held before the joint committee of Congress investigating the Department of the Interior and the Bureau of Forestry, vol. 3, 1910, pp. 2108–2370.

[b] Data from hearings of joint committee, etc., vol. 5, 1910, pp. 3816–3820.

Seward have been completed, bringing the track to the head of Turnagain Arm at a cost of about $5,000,000. The company reports that between Seward and the coal field the maximum grade is 2.2 per cent and occurs at only one place. The first and second summits from the coast are reached from tide water at a grade of 2 per cent.

Besides these lines some preliminary work was done in 1909 on a railway from the mouth of Edwardes River, Controller Bay, to the Bering River coal field (27 miles). Surveys were also made of one line from Katalla and another from Kanak Island, both of which extend to the coal field. Apparently no work has been done for the proposed railway line from Valdez to the Chitina copper district, though some additional surveys were made. The project of a railway from Cook Inlet to Iliamna Lake and on to the Kuskokwim also appears not to have been pushed. Besides the projects and railways under construction, as noted above, the White Pass and Yukon Route from Skagway, the Tanana Valley Railway at Fairbanks, the Seward Peninsula Railway and the Council City and Solomon River Railway of Seward Peninsula, and the short line, known as the Yakutat Southern Railway, at Yakutat Bay were operated.

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

Mileage and terminals of Alaska railways, December 31, 1909.

	Miles.
Southeastern Alaska:	
White Pass and Yukon Route, Skagway to White Pass (narrow gage). Terminal at White Horse, Yukon Territory. Total mileage, 102 miles	20.4
Yakutat Southern Railway, Yakutat to Situk River (narrow gage)	9±
Copper River:	
Copper River and Northwestern Railway, Cordova to Tiekel (March 25, 1910) (standard gage)	102.0
(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 Northern Railway, Seward to a point near head of Turnagain Arm (April 16, 1910) (standard gage)	70.0
Yukon basin:	
Tanana Valley Railway, Fairbanks and Chena to Chatanika (narrow gage)	46.0
Seward Peninsula:	
Seward Peninsula Railway, Nome to Shelton (narrow gage)	80.0
Paystreak branch Seward Peninsula Railway (narrow gage)	6.5
Council City and Solomon River Railway, Council to Penelope Creek (standard gage)	32.5
Wild Goose Railway, Council to Ophir Creek (narrow gage)	5.0
	371.4

Portions of railways in Seward Peninsula are out of repair and not in use.

The construction of railways emphasizes the need of supplementing them by wagon roads and trails. Much has been accomplished in the way of trail and road construction since the Alaska road commission was organized in 1905. At the close of 1909 [a] 720 miles of wagon road, 421 miles of sled road, and 203 miles of trail had been built and 927 miles of trail had been staked. In addition to this, some trails had been built by private initiative. While some of the mining districts, like those of Nome and Fairbanks, have been rendered fairly accessible by wagon roads,[b] in many others the conditions of travel are almost as primitive as ever. The total amount of road and trail construction is insignificant by comparison with what is urgently needed.

METAL MINING.

INTRODUCTION.

In 1909, as in 1908, about one-fifth of the gold production came from lode mines and four-fifths from placer mines. As the lode production is increasing far more rapidly than that of the placers, this ratio will not continue indefinitely, but there is no reason to believe that the ratios will change materially for several years. In the following table the metal production has been distributed as to source. As complete statistical data are not yet at hand, there may be an error of 5 or 10 per cent in these figures.

Sources of gold, silver, and copper in Alaska, 1909.

	Gold.		Silver.		Copper.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.	Quantity (pounds).	Value.
Siliceous ores	198,693.69	$4,107,363	30,118	$15,661	.....	.....
Copper ores	1,608.61	33,253	22,549	1,170	4,124,705	$536,211
Placers	789,576.76	16,323,000	74,239	38,603	.....	.....
	989,879.06	20,463,616	126,906	55,434	4,124,705	536,211

Gold mining began in Alaska thirty years ago. Its gradual advancement until the first exploitation of the Nome placers in 1899 is reflected in the following table, which exhibits the annual metal production. A second great advance in production was made in 1905, when the Fairbanks district first yielded a large output of gold.

[a] Richardson, W. P., Annual report of the road commissioners for Alaska, 1909: H. R. Doc. 864, 61st Cong., 2d sess.

[b] It should be noted that these roads have been built in part by the funds derived from local taxes.

The exploitation of the elevated beach lines at Nome and of rich creeks at Fairbanks again brought up the gold output in 1906, since which time it has fluctuated somewhat but has not varied greatly. An abortive attempt at copper mining was made on Prince of Wales Island as early as 1880, but the systematic exploitation of copper deposits did not begin until 1901, when the Gladhaugh mine on Prince William Sound began shipping ore. The fluctuations in the copper output are due largely to variations in the value of the metal in different years. The silver production is practically all represented by the recovery incidental to mining placer and lode gold.

Production of gold, silver, and copper in Alaska, 1880–1909.

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	1,033,000	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	9,160,400	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	1,261,757
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267
1909	989,879	20,463,000	126,906	65,991	4,124,705	536,211
	7,632,092	162,686,455	1,939,737	1,184,259	29,553,419	4,800,014

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. 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 some small quartz mines in the Susitna basin and on Kenai Peninsula, 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 and in the Fairbanks district.

Value of gold production of Alaska, with approximate distribution, 1880–1909.

Year.	Pacific coast belt.	Copper River and Cook inlet region.	Yukon basin.	Seward Peninsula and northwestern Alaska.	Total.
1880	$20,000				$20,000
1881	40,000				40,000
1882	150,000				150,000
1883	300,000		$1,000		301,000
1884	200,000		1,000		201,000
1885	275,000		25,000		300,000
1886	416,000		30,000		446,000
1887	645,000		30,000		675,000
1888	815,000		35,000		850,000
1889	860,000		40,000		900,000
1890	712,000		50,000		762,000
1891	800,000		100,000		900,000
1892	970,000		110,000		1,080,000
1893	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	3,448,318	401,500	10,323,000	5,120,000	19,292,818
1909	4,206,000	375,000	11,580,000	4,302,000	20,463,000
	47,966,255	4,118,500	56,917,000	53,684,700	162,686,455

LODES.

Systematic auriferous lode mining in Alaska began with the opening of the Treadwell mine in 1882, and since then this industry has made an output of 2,146,551 fine ounces of gold, valued at $44,466,698, and 968,518 fine ounces of silver, with a commercial value of $594,163. The total copper production up to the close of 1909 was 29,553,419 pounds, valued at $4,800,014. There has also been a small production of tin, chiefly recovered from placers. Some tungsten and antimony have been produced incidentally to prospecting, and some lead has been recovered from Alaska ores. Other ores, such as magnetite, hematite, and chromite, are known to occur in the Territory but have not been developed on a productive basis.

The year 1909 witnessed a marked advance in the auriferous lode mining industry of the Territory, both in the output of the produc-

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

ing mines and in the development of new prospects. Alaska's auriferous lode mines produced during the year 198,693 fine ounces of gold, valued at $4,107,363, as compared with an output of 162,411.08 fine ounces, valued at $3,357,335, in 1908. The increased production came largely from the Juneau district, but new lode prospects were discovered in many parts of the Territory. Noteworthy among the lode developments are those of Fairbanks, of Kenai Peninsula near Seward, and of Willow Creek, in the Susitna basin. Some advance was also made in lode prospecting in Seward Peninsula and in the Chandalar and some of the other Yukon districts.

The development on but few of these newly discovered lodes has gone far enough to permit their being designated as mines. For this reason the number of productive gold lode mines is the same as in 1908, namely, 12. But in addition there are at least a score of prospects that are being systematically developed, some of which have made a small output.

The output of the auriferous lode mines in 1909 is estimated at 1,490,000 short tons, as compared with 1,477,436 short tons in 1908. The average value of the gold and silver recovered in 1909 is estimated at $2.78 a ton. The low values reflect the domination of the output of the Treadwell group of mines in the total.

Copper mining was less active in 1909, when seven properties were productive, as compared with nine properties in 1908. This was due to the discouragement caused by the continued low price of copper. With the opening of the Bonanza mine and others in the Copper River region, together with some on the coast, a large increase in the annual copper production is to be expected within the next two years. In 1909 about 35,000 short tons of copper ore was hoisted, as compared with 51,509 tons in 1908. The average copper content of the ore in 1909 was about 5.4 per cent, and the gold and silver values were about $1.15 a ton.

Most of the important lode districts of Alaska are covered by special reports in this volume and need no discussion here. The region about Juneau continues to be the only important lode-gold producer, but there is every reason to believe that the auriferous lodes of Berners Bay region will soon make a large output. Prince William Sound is known chiefly as a copper producer, yet some promising gold-bearing lodes have been found near its shores. Several of these are being systematically prospected, and at one, near Valdez, a small stamp mill has been installed. A number of auriferous lodes are being systematically developed on Kenai Peninsula, near the town of Seward. The Apollo mine, on Unga Island, has been operated throughout the year, and other properties in the vicinity are being carefully prospected.

Much work was done on the auriferous quartz veins of the Willow Creek region. Unfortunately, it has been impossible so far for the Survey to investigate these deposits, but the following notes are based on data that are believed to be reliable.

The district lies about 30 miles north of Knik, which is accessible by steamer and with which it is connected by horse trail. According to Paige and Knopf,[a] Willow Creek follows the contact between a quartz diorite and granite mass on the north and a belt of garnetiferous mica schists and chlorite-albite schist on the south. The placer gold of this district, according to the same authors,[b] is derived from quartz stringers in the schists. Since they made their examination some auriferous quartz veins have been found in this district, and these are reported to occur chiefly in the granite. This occurrence may be due to the fact that the deformation of the region might open well-defined fissures in the massive granite, while in the schist the stream would produce zones of shattered rock. There is not evidence enough in hand to make a definite statement, but it appears that the placer gold has been derived from the schists, while the gold-quartz veins that have been opened occur chiefly in the granite. The quartz veins carry free gold, iron, arsenopyrite, and possibly chalcopyrite. High gold values, but only very low silver values, are reported. In one deposit free-milling gold quartz was found at the surface and to a depth of 50 feet, where the lode gradually became refractory.

Four companies are said to be doing systematic work in this district. The Gold Bullion Mining Company has a property on Cragie Creek, a northerly tributary of Willow Creek. So far only open-cut mining has been done; but this work, according to W. E. Bertholf, the manager, has uncovered a vein that varies from 18 inches to 5 feet in width and has been traced through several claims. A 2-stamp mill, installed in 1908, was operated for about three weeks in 1909 with favorable returns.

The Alaska Gold Quartz Mining Company has a property on Fishhook Creek, a tributary of the Little Susitna. According to J. S. Carle, the manager, the vein has been followed by an adit tunnel for 140 feet, with a width of 2 to 5 feet. A 3-stamp mill was installed in the summer of 1909 and operated for a part of the season. At 50 feet from the mouth of the tunnel the vein changed from free-milling to base ore, and operations were suspended until a concentrating table could be installed.

The Brooklyn Development Company also has a property in the same district. In the fall of 1909 contracts were let by this com-

[a] Paige, Sidney, and Knopf, Adolph, Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska: Bull. U. S. Geol. Survey No. 327, 1907, p. 10.

[b] Idem, p. 66.

pany to drive a 100-foot tunnel, and a 2-stamp mill was brought to Knik, which will be taken to the claim during the winter. No details were learned regarding the Gold Top Mining Company.

In addition to the work noted above, considerable prospecting was done in the Willow Creek district and in the adjacent regions. Both quartz and copper lodes are reported at various places. This preliminary work on the Willow Creek quartz veins led to a gold production of the value of about $25,000, which is a remarkably good record in view of the fact that milling was limited to only a few weeks.

The most important development of auriferous lode mining in the Yukon basin is that of the Fairbanks district. Some promising gold-bearing quartz veins have also been found in the Chandalar district, but not much work has been done on these.

Much interest was excited among mining men by the discovery of auriferous lodes near the northern base of the Alaska Range and in the Bonnifield placer district. These lodes lie about 40 miles south of Fairbanks and can be reached by a direct trail during the winter. In summer they are accessible only by long horse trails, via either the Little Delta or the Nenana. Little information is available regarding this region, as it has not been surveyed. From the reports at hand it appears that there are two types of deposits; to the one belong the auriferous quartz veins of the region, to the other the mineralized zones in a sheared and much altered rhyolite. Only one deposit of the latter type has been reported. This, the Jerome ledge, occurs on Chute Creek, a tributary of Wood River. It is stated that a mineralized belt of rhyolite has been found which has a width of 250 feet and can be traced a long distance. This is said to carry gold values. Through the courtesy of Mr. R. M. Crawford the writer was able to examine a specimen of this ledge. It is a bluish rock, in which small vitreous quartz and feldspar crystals can be seen. The rock is impregnated throughout by iron pyrite, which probably carries the gold. There is no evidence of secondary quartz veins in the rock, the pyrite being the only evidence of mineralization. The owners report assays of $5 in free gold, $4 in concentrates. Some very high values have also been found in the rock. A very unpromising looking fragment of rock said to come from this deposit was assayed for the writer by Ledoux & Co., who reported $1.03 in gold and a trace of silver.

The Jerome ledge is well exposed and, the owners claim, has been carefully sampled, with the results given above. An adit tunnel has been driven for some distance and the material passed through a small prospecting mill. If the deposit is as large as reported, it ought to be possible to develop it in spite of its comparatively low values and its difficulty of access. Altered rhyolite of this type has been seen by the writer on Nenana River and appears, there-

fore, to be widely distributed. If the Jerome ledge proves to be a valuable deposit, other similar rocks of the region should be examined by the prospector. Auriferous quartz veins carrying other metals have also been reported from the Bonnifield district.

The reported development of two ore bodies carrying gold values in the Klondike district near Dawson is a significant fact for the lode miners of the Alaska Yukon. These deposits have been recently described [a] as follows:

The workings (Lone Star mine) are situated at the head of Victoria Gulch, a tributary of Bonanza Creek. Victoria Gulch is the upstream end of the placer gold on Bonanza Creek, and as the gulch is rich in gold from its mouth to its source it is generally believed that the Lone Star vein was an important source of the supply of placer gold on Bonanza and on Eldorado creeks. An extension of the lode cuts the latter creek well up toward the end of discovered pay.

The lode was located nine or ten years ago and has always been considered valuable, but unfortunately litigation has prevented its development. The deposit has been described by R. G. McConnell, of the Canadian Geological Survey, as a stockwork paralleling a fissure vein. The hanging wall consists of contorted schist, and the apparent foot wall is made up of solid gray schist, possibly an altered porphyry. Lying next to the foot wall is a lode of quartz 4 feet wide. Between this and the hanging wall there is a body of blue clay fully 10 feet wide on the surface, containing a large percentage of iron pyrite of undetermined value. The trend of the lode is north and south. The stockwork before mentioned is crosscut by this fissure at an angle of about 45°, showing the fissure to be a newer deposit. It consists of contorted ribbon rock containing a fair amount of gold and dips slightly toward the hanging wall of the fissure. This older deposit has been traced for a distance of 400 feet in length; its width has not been determined. An open cut has been run on this deposit at a depth of 20 feet along its general course. This cut shows a stockwork of schist and quartz veins more or less parallel. The trend is southeast. The north and south fissure has been definitely traced for a distance of 1,500 feet. For this distance it carries its width of 4 feet. The clay is also found to continue and maintain its character for this distance. The vein for its whole determined length shows free gold which may be obtained by panning. Twenty tons crushed some years ago as a test gave $407 gold, and the many samples taken would indicate its value to be from $17.50 to $20 per ton free gold. Whatever gold is contained in the concentrate must be added to this. The clay carries small amounts of free gold. The pyrite, of which there is a large percentage, has not yet been properly tested but is known to be valuable.

Two shafts, one 40 and the other 50 feet deep, have been sunk on the vein. These show the ore to be of the same width, character, and value as on the surface. An adit has also been started at a point which will tap the lode at a depth of 100 feet, in a distance of 210 feet; this will be used as a drain for the first level and also for taking out the rock. Toward the end of the season a mill run of 410 hours was made on rock from the stockwork or older deposit, 100 tons of unselected rock being crushed, returning $1,334. During the last thirty hours of this run an amalgam trap was used, recovering 3½ ounces of amalgam, leading those in charge to believe gold has been lost before.

The equipment consists of a 2-stamp Hendy mill placed 200 feet below the level of the open cut and about 300 feet distant, a Challenge ore feeder, Blake crusher and ore bins, 30-horsepower steam boiler, and 20-horsepower horizontal engine, a dynamo and all necessary tools, 3,000 feet of rails, a gravity tram, and self-dumping cars which discharge directly into the ore bins. All necessary buildings have been put up in a sub-

[a] Lewington, Guy A. R., Quartz mining in the Yukon Territory: Min. and Sci. Press, January 1, 1910, p. 65.

stantial manner. It is expected that the mill will be enlarged just as soon as the ore body has been definitely traced and its value established. The small plant now at work will keep development going.

Development work is also well under way on the property of the Dome Quartz Mining Company. This mine is situated on a divide between Lombard and Dominion creeks and is owned principally by Hartman & Davidson. During the latter part of last winter an adit was started for the purpose of cutting the lodes, of which there are five, at a depth of 600 feet below the outcrop. This adit has always seemed an ill-advised undertaking, on account of the risk and cost. However, nothing succeeds like success. It is now in about 1,000 feet and has tapped two of the veins, which are found to show their full width and value. The other three veins, it is hoped, will be crosscut some time next year. This will require about 500 feet of additional driving. The property is generally believed to be of value. The crosscutting of two lodes at a depth of 600 feet and the finding of 3 feet of ore in each vein with gold that will certainly pay places the property in a most enviable position and is a matter of great satisfaction to all concerned.

The Klondike placer district lies in the eastern extension of the Yukon-Tanana region. So far as known the geologic conditions of the Klondike repeat themselves in the various placer districts of the Yukon-Tanana region. For this reason the definite proof of the occurrence of workable auriferous lodes in the Klondike district points to the conclusion that similar discoveries will be made in the Alaska part of the belt.

But little progress was made in lode mining on Seward Peninsula during 1909. The Hurrah quartz mine was idle during the year, but as the ownership of the property has changed, it seems probable that it will soon again be operated. Some development work was done on the Alaska Chief, a galena deposit located on Lost River. Work was continued at a number of auriferous lode prospects, notably the McAllister, at the head of Nome River. It is reported that systematic work was also done on an auriferous lode prospect near Bluff and on the Slisco antimony property on Hobson Creek. Though the excitement of a few years ago, caused by the discovery at several localities of gold-bearing quartz, has died down, considerable lode prospecting is still going on.

While the low price of copper did not encourage extensive mining of this metal, yet a number of copper mines were operated throughout the year, and in the aggregate considerable development work on copper properties was accomplished. The most important fact bearing on the industry was the continuation of work on the railway which will open the Chitina copper district. As the accompanying reports cover the advancement in all the more important districts—southeastern Alaska, Prince William Sound, and the Chitina region—it will not be necessary here to consider the copper-mining industry at length. In southeastern Alaska one new mine, the Goodro, was put on a productive basis in 1909, and three others—the It, the Mount Andrew, and the Jumbo—were operated throughout the year. Dead

work was also done on a number of other properties in this district. In Prince William Sound the Bonanza continued its heavy shipments throughout the year. The Standard and Gladhaugh were also productive, and other deposits were systematically developed. Work also continued on a score of properties in various parts of Alaska, including the Nabesna-White River region, Kenai Peninsula, Iliamna Lake, and Seward Peninsula.

TIN.

Though the output of tin was small,[a] considerable prospecting was done. Some activity was manifested in the tin region of western Seward Peninsula during the summer of 1909. On Cape Mountain the United States Alaska Tin Mining Company employed a crew of six men, and the tunnel, which at a depth of 266 feet is planned to undercut a quartz vein exposed on the surface, striking N. 45° W. (magnetic) and dipping 80° N., has now been driven approximately 450 feet through hard, solid granite. If the ledge maintains the dip shown in the outcrop, the tunnel must intersect the ore body within a short distance and will afford information as to the character of the vein at this depth, which will be the greatest yet attained in the entire tin region. On the Bartells property the operations of the season were restricted to the accomplishment of the annual assessment work. The mineral claims of the two companies mentioned above were surveyed for patent during the summer. Some productive work was done on the placer deposits of Buck Creek. At Lost River the main efforts of the season were devoted to the recovery of stream tin occurring on Cassiterite Creek in the vicinity of the tin-bearing dikes. On Brooks Mountain development work was continued on the contact-metamorphic deposits, one of which is known to be stanniferous to some extent, and encouraging results are reported. Stream tin has been reported from a number of creeks in the Yukon basin, and considerable tin is reported in the placers on Sullivan Creek, in the Hot Springs district. On Deadwood Creek, in the Birch Creek district, stream tin occurs in association with wolframite.

GOLD PLACERS.

INTRODUCTION.

The placer-gold production of Alaska for 1909 is estimated at $16,322,000, as compared with $15,888,000 in 1908. This increase must be credited in great part to districts of the Yukon basin, nearly all of which had a larger production in 1909 than in 1908. On the other hand, the dry weather led to a marked falling off in the placer-gold output in some other districts.

[a] The production is not given, as it was almost all from one property.

Perhaps the most significant fact of the year's operations is the continued activity in installing dredging enterprises. Five dredges were operated in Seward Peninsula throughout the open season, and six more were completed in time to do some work, making eleven dredges, small and large, which were in use during 1909. The results of these enterprises have encouraged many to take up this form of mining, and plans for several more dredges have been made. Three dredges were operated in the Fortymile district. Plans were also formulated for dredges at Fairbanks. Some examinations have been made for a dredge on Kenai Peninsula.

The results of the dredging operations at Dawson are of interest to the Alaska mines, as they indicate something of the cost of large enterprises in the Yukon basin. The annual report of the Yukon Gold Company [a] contains this statement in regard to the dredging operations:

> The Yukon country, in 1909, experienced a late spring with a correspondingly late opening of the navigation and mining operations. The seven dredges, the last of which was completed late in 1908, started as early as power was available. The last dredge began operation on June 9, 1909. The dredging season for six out of the seven dredges was 132½ days as against a normal season of 140 days. The running time of one dredge, No. 5, was curtailed on account of local conditions. The dredges during the season handled 2,381,880 cubic yards and produced $1,363,722 worth of gold. The value per cubic yard was 57.24 cents and the cost 31.94 cents per cubic yard. This cost includes all thawing charges—amounting to 15.45 cents per yard—preliminary stripping operations, and depreciation at the rate of $2,000 per month per dredge. As an example of what may be expected in ground entirely thawed, the No. 1 dredge handled in the month of August 100,217 yards at a cost of 9.28 cents per yard.
>
> It is worthy of note that the actual value per yard of material handled exceeded the estimated value based on examination results by 16.8 per cent. The cost per yard was 6 per cent higher than the estimated cost for the season, but it is less than the estimated average cost for handling the creek deposit by 8.6 per cent. The dredges operated 83.5 per cent of the possible running time.

Less definite data are available regarding the cost of dredging in other parts of this northern field. On Seward Peninsula only unfrozen ground has been dredged, the cost per cubic yard, including overhead charges, being placed at 18 cents. In a region where fuel is so expensive as in Seward Peninsula (coal costs $20 a ton) it is not likely that mining men will be encouraged to attempt the thawing of ground for dredging. In parts of the Yukon basin, with a considerable supply of wood and an abundance of lignitic coal, it seems economically possible to dredge frozen ground; at least this method of handling the gravels is being seriously considered. It should be remembered that gravels which run less than, say, $2 to the yard can not be mined under present conditions, while such values would be regarded as extraordinarily high in dredging ground.

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[a] Eng. and Min. Jour., March 19, 1910, pp. 602-603.

SUMMARY OF PLACER MINING BY LOCALITIES.

PACIFIC COAST REGION.

For the purposes of this discussion the Pacific coast region will be made to include not only the seaboard but also the drainage basins tributary to it, including the Copper and Susitna. The placers of this province are estimated to have had in 1909 an output valued at $490,000, as compared with $450,000 in 1908.

Southeastern Alaska.—Placer mining was carried on during 1909 in the Porcupine district and on Gold Creek in the Juneau district. In the former district the Porcupine Gold Mining Company completed a bed-rock flume nearly 2,000 feet long, and installed a trolley lift with buckets of 2½ cubic feet capacity and with automatic dump. The plant installed provides for the piping of the gravels into the buckets at bed rock and lifting them to a hopper that discharges into the sluice boxes. This plant was not finally completed until late in the season, but was then operated. Some smaller operations also were carried on in the district.

Beach mining.—As in previous years there was more or less beach mining along the Pacific shore between Yakutat and Unga Island. This is all done by men working with rockers or small string boxes. The recovery of gold is in many places dependent on weather conditions, for the operations are most profitable after a heavy surf has concentrated the gold in the surface layer of sand. The most important center for this form of mining is at Yakataga, near Controller Bay. Though it is impossible to procure accurate statistics, the entire production of the Pacific seaboard is probably not over $25,000 in value.

Copper River region.—The Copper River region includes two placer districts. One of them, the Nizina district, in the upper Chitina, is described by F. H. Moffit in this volume. The Chistochina district, sometimes known as the Chisna, is in the northern part of the Copper basin. It is one of the most inaccessible of the Alaska placer camps, being reached now only by trail from Valdez, a distance of about 250 miles. Winter freight rates have been about $500 a ton. Because of these costs it has been possible to exploit only the richest gravels. As a consequence the camp has not attracted many miners. Conditions are improving, both because of the construction of the wagon road to Fairbanks, the route of which passes within 25 miles of the camp, and because of the building of the Copper River and Northwestern Railway, transportation over which will avoid the cost and delays of hauling freight over the Valdez summit. The improvement in the trail has already brought freight rates down to $300 a ton.

It is reported that 24 claims were worked in this district by about 100 men in 1909, and the total production is estimated to have a value of $112,000. Considerable prospecting of bench claims on the lower Chisna was carried on. Some work was also done on a ditch to bring water to these bench claims and on a tunnel intended to tap an old channel on Daisy Creek. As in previous years, most of the gold was taken from Slate and Miller creeks.

Sunrise district.—The placers of the northern part of Kenai Peninsula included in the Sunrise district are being worked, but the gold output is small. Bear, Resurrection, and Canyon creeks are the largest producers. This district is rendered easily accessible by the Alaska Northern Railway, supplemented by a wagon road which has been built by the road commission from Trail Lake to Sunrise and Hope. In view of these facilities, mining costs should be low. A number of plans are being considered for the installation of hydraulic and dredging plants. Because of the presence of large glacial bowlders in many of the gravels, the hydraulic method would appear to commend itself more than dredging. It is possible, however, that the gravels of some of the streams may not contain enough bowlders to seriously interfere with dredging, but it would seem desirable that careful prospecting with a drill be done to determine the character of the material before a dredge is installed.

Cook Inlet.—So far as known the only prospecting in the Cook Inlet region during 1909 was that done on Beluga River. Fine gold has long been known to occur in the alluvium of this stream. In 1902 an attempt was made to mine it with the aid of a hydraulic plant, but this was soon abandoned. Operations in 1909 consisted in prospecting for dredging ground, but the results are not available for publication. This is one of the fields where large glacial bowlders are likely to be found in the alluvium, a fact which should be taken into account in the choice of a method of mining.

Susitna basin.—The Susitna basin can be divided geographically into three districts—Willow Creek, Yentna, and Valdez Creek. The lode deposits of Willow Creek, the center of interest to the miners and prospectors, have already been described. (See p. 35.) There was also some placer mining, notably on Grubstake Gulch, where the hydraulic plant of the Klondike Boston Mining Company is located. The water supply, which is reported to have been abnormally low, is said to have permitted the plant to run for only forty-seven days during the season. One giant is said to have been used.

Some prospecting was done on Metal Creek, a tributary of Knik River. The results are said to have been encouraging and plans for further development have been made.

Valdez Creek is a tributary of the upper Susitna, being about 160 miles by trail from Valdez. Its isolation has made mining costs very

high. Winter freight rates are $600 to $700 a ton, while the cost of transportation by pack horse in summer, either from the mouth of Indian Creek, which can be reached by boat up the Susitna, or from Gulkana, on the Copper, is $2,000 a ton. In 1909 about 100 men were working in this district on about ten claims, and the gold output has a value between $50,000 and $75,000. The gravels are thawed, which increases the cost of mining.

The Yentna basin is the most prosperous of the Susitna districts. Winter freight rates from Susitna River are about $200 a ton. There were between 120 and 150 miners in this district in 1909, and the gold output is valued at $100,000 to $120,000. The productive placers occur in two districts. One includes Cache and Peters creeks and their tributaries and the other includes Wagner Creek and some other tributaries of Lake Creek. Plans have been made for installing several hydraulic plants in this district in 1910. There is much auriferous gravel in which the values are too low to permit profitable exploitation by hand methods.

YUKON BASIN.

General statement.—The Alaska Yukon placer districts had in 1909 the most profitable season since mining first began there, nearly a quarter of a century ago. The estimated value of the gold output is $11,580,000, as compared with $10,323,000 in 1908. Progress in mining in most of the important camps of the Yukon is covered by the reports of Mr. Ellsworth and Mr. Maddren in this volume and will need no detailed description here. It is of interest to note that the gold output of the Klondike, in Canada, which had rapidly declined in the last few years, showed a decided increase in 1909. It is to be expected that all the Alaska camps will eventually pass through the same history—first a very large production, when the richest placers are worked, then a gradual decline, until the introduction of large plants revives mining activity.

While practically all the Alaska Yukon camps made an increased production in 1909 as compared with the previous year, those of the Tanana Valley were the most prosperous. The various districts tributary to the lower Tanana are estimated to have produced gold to the value of over $10,150,000. Of this, Fairbanks made an output estimated at $9,650,000, as compared with $9,200,000 in 1908. The general prosperity is also indicated by the value of the merchandise shipped to the Tanana Valley from the United States, which was $2,637,476 during the fiscal year ending June 30, 1909, as compared with a total of $2,040,628 for the previous fiscal year.

In spite of this evident prosperity, it can not be denied that the time is rapidly approaching when the gold production of the Fairbanks district will decline unless some radical changes are made in

mining methods. So far as present methods of exploitation are concerned, many of the richest creeks are nearly worked out. Little appears to have been accomplished in the matter of preparing to mine the gravels of lower gold tenor, though some plans for dredges are under way. Meanwhile, much enterprise has been turned toward the search for auriferous veins, which should yield results assuring permanency to the camp. A lode-mining industry, however, is not likely to develop fast enough to make up for the decreased production of the placers. The Fairbanks miners could well follow the lead of those of the Fortymile district, where three large plants are holding up the gold output in spite of the decrease in small operations.

The Haiditarod excitement has hurt the Fairbanks district by drawing away some of the most enterprising operators and also a large percentage of its mine labor. This may lead to a falling off of the gold output in 1910.

Probably the most important feature of the year's mining industry in the Yukon is the general drift to the Innoko region, for there is in every camp a large class of restless prospectors who are ready for a venture in a new field. The continued increase in gold production of the Koyukuk is worthy of note, though the high costs of operating have prevented a proportionately prosperous community. The continued success of the dredges in the Fortymile district has already been referred to as an important feature of the year's mining.

Bonnifield district.—Considerable more work was done in the Bonnifield district in 1909 than in any previous year. This work in part consisted of mining, but more important were the steps taken to install a large hydraulic plant on Gold King Creek, where there is said to be a large body of auriferous gravels. As a preliminary to this installation a winter sled road was cut through from Fairbanks, a distance of about 40 miles. Considerable work was also accomplished in installation of the plant, which it is expected will be ready for operating in 1910. The gold values of the gravels are said to be low, but there is reported to be ample water for a hydraulic plant. Gold King, Grubstake, and Platt creeks are the chief gold producers of the district. The total gold output in 1909 is estimated to have a value of over $50,000.

Kantishna district.—There appears to have been but little mining in the Kantishna district during 1909. The gold output, all of which came from a few small operators, is unknown but probably did not exceed a few thousand dollars in value.

Gold Hill district.—There was renewed activity in the Gold Hill district during 1909. Productive mining appears to have been confined to Mason and Grant creeks, but good prospects were also reported on other streams. In the fall of 1909 twelve claims were being opened on Grant Creek, and the results will probably indicate

definitely whether the gravels carry values. Placer gold has long been known to occur in this district,[a] but it has never been carefully prospected.

Innoko district.[b]—A new movement of population into the Innoko district was brought about by the discovery of gold placers on Otter Creek, a northerly tributary of Haiditarod River, which drains the southern part of the field. Thousands of prospectors and miners flocked into this field during 1909 from all parts of Alaska as well as from points outside of the Territory. The movement promises to become one of the important ones in the history of Alaska. To judge from the best information available, the discovery on Otter Creek does not, in point of either value or extent of deposits, warrant this large influx of prospectors. At the same time it also appears to be true that auriferous gravels are distributed over a considerable area and that gold in quantities sufficient for profitable exploitation has been found in several widely separated localities. It is probably safe to say that although the district may not be able to support the extensive population it has recently acquired, yet it certainly offers a promising field for the prospector.

High freight rates, absence of trails, and lack of established centers of distribution continue to make the cost of mining and prospecting very high. Travel in summer is chiefly by steamer and small boat up the Innoko from the Yukon. Winter travel is from Kaltag on the Yukon, but some have made the long trip from Cook Inlet through the Alaska Range at Rainy Pass, a distance of about 325 miles. The Kuskokwim route has been little used, chiefly because the mouth of the river is uncharted. The Haiditarod basin has not been visited by any member of the Geological Survey. It is reported that the discovery on Otter Creek consisted in finding a bed of gravel 4 feet thick and 50 to 60 feet wide which carried 7 to 10 cents to the pan. The gold is said to be fairly fine, of a uniform size, and evenly distributed. Most of the gold in 1909 was taken from Gaines and Ophir creeks. The value of the aggregate output of the year is unknown but is variously estimated at $300,000 to $400,000; that of the 1908 output was less than $100,000.

The reports from the Innoko during the last year have been so conflicting that it is impossible to form any just estimate of the actual condition of the mining industry. On the one hand, many have left the new camp, discouraged at the outlook, but on the other, many experienced miners have remained in the country and expressed entire confidence in its future importance. Another year should yield more definite information. A survey of the Innoko district is to be made by the Geological Survey in 1910.

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[a] Maddren, A. G., The Innoko gold-placer district, Alaska: Bull. U. S. Geol. Survey No. 410, 1910, pp. 81-83.

[b] Maddren, A. G., op. cit.

KUSKOKWIM BASIN.

The movement of prospectors brought about first by the discovery of the Kantishna and later by that of the Innoko has led to considerable prospecting in the Kuskokwim basin. Though both placer and lode gold have been reported from many localities, so far as known the only productive mining has been on Tuluksak River, a tributary of the lower Kuskokwim. A few claims in this district were operated in 1908, and it is reported that about 20 men were at work on this stream in 1909. Good prospects are also reported on the Takotna, a tributary of the Kuskokwim, which heads against the Innoko. In 1908 some good prospects were found on tributaries of Hartman River, which forms a part of the drainage of the south fork of the Kuskokwim. It was estimated that the deposits would yield $8 a day to the man, a recovery which, in view of the isolation of the region, hardly justified operations. If a trail were built from Knik to the Innoko, it would pass through this district.

NORTHWESTERN ALASKA.

Northwestern Alaska, as the term is here used, embraces the placers of the Norton Bay region, Seward Peninsula, and the Kobuk basin. The mining progress in the first two is treated in separate articles in this volume.

With the exception of operations on a few productive claims on Bonanza Creek (Norton Bay) and on some in the Kobuk Valley, all the gold mining of northwestern Alaska is confined to Seward Peninsula. As has been indicated, productive mining on the peninsula received a setback in 1909 as compared with 1908. On the other hand, considerable dead work was accomplished preparatory to the installation of dredges. In the development of dredging enterprises the Seward Peninsula operators have made more progress than those in any other part of Alaska, and notably so in 1909. It is an open question whether the gold output will again attain the maximum of previous years, and certainly not for some time to come; but the peninsula should with the installation of the dredges now planned, which will make 12 or 15 in all, enter upon an era of steady prosperity. It is not to be expected that such a dry season as that of 1909, which was the chief reason for the decreased gold output, will recur for several years. The fact can not be denied, however, that the records for four years indicate that low-water conditions are normal and high-water conditions abnormal, and that the methods of mining will have to be adjusted to this fact.

The Kobuk Valley continues to support a small placer-mining population. In 1909 claims were worked by 16 men, with a total value of output of about $16,000. Dahl Creek was the largest producer and Shingnek Creek second; some gold was taken out of Riley Creek. The sluicing season in 1909 was very short, as there was no water after August 1, a fact which materially reduced the production.

ALASKA COAL AND ITS UTILIZATION.

By Alfred H. Brooks.

INTRODUCTION.

It is the purpose of this article to present a brief description of the Alaska coal fields and to discuss their availability as a source of fuel and the possible market for their output. Almost all the data used in this compilation are taken from the reports of the Geological Survey. A full list of these publications is appended (pp. 95–100), but it does not seem best to give a specific reference for each statement of fact. It will suffice to state that the writer's own field work in the coal fields has been very slight, and hence the descriptive matter here included must be credited to the many geologists who have investigated Alaska coal resources. Special acknowledgement should, however, be made to George C. Martin, whose reports [a] have been very freely drawn upon in the preparation of this paper. Mr. Martin has not only personally investigated the two most important fields, but has prepared summary statements of the fuel resources of all Alaska and has discussed the question of markets.

GEOLOGIC DISTRIBUTION OF COAL.

The geologic age and sequence of the several coal-bearing formations have not been very definitely determined. Detailed surveys have been made only in the Bering River field, where the structure is so complex that the results are far from conclusive. It seems, however, to be pretty well established that nearly all the coals which are of present commercial importance are of Tertiary age, and that a large part belong to the Kenai formation (Eocene).

The oldest coals known in Alaska are some which are of a high-grade bituminous character and occur near and south of Cape Lisburne, on the Arctic Ocean. These are contained in a formation of Mississippian (lower Carboniferous) age, made up of slates and limestones. On the upper Yukon is a series of conglomerates, sandstones,

[a] Martin, G. C., Markets for Alaska coal: Bull. U. S. Geol. Survey No. 284, 1906, pp. 18–29; Preliminary report on the Matanuska coal field: Bull. U. S. Geol. Survey No. 289, 1906; The Alaska coal fields: Bull. U. S. Geol. Survey No. 314, 1907, pp. 40–46; The geology and mineral resources of the Controller Bay region: Bull. U. S. Geol. Survey No. 335, 1908.

and shales (Nation River formation) which carries some thin beds of bituminous coals. This formation is Carboniferous and has been provisionally assigned to the Pennsylvanian epoch. The next higher coal-bearing beds are in the Corwin formation, which occurs about 20 miles east of Cape Lisburne. This formation is made up of shales, sandstones, and conglomerates and includes a large number of beds of subbituminous coal. It has been referred to the Jurassic period. A coal-bearing formation of about the same age has been recognized in the Matanuska Valley, northeast of Cook Inlet, but no Jurassic coals are known elsewhere in Alaska. Upper Cretaceous coals have been found in southeastern Alaska, on the Alaska Peninsula, on the lower Yukon, and in the Colville River basin. Except in southeastern Alaska, where only lignite has been found, the Cretaceous coals are chiefly bituminous. Lithologically the Upper Cretaceous rocks vary in different localities, but as a rule they are composed predominatingly of the finer clastic material and limestones.

The Kenai formation (Eocene) is by far the most important of the coal measures. It has been found in large and small areas almost throughout Alaska and nearly everywhere carries some coal. It is typically made up of coarse and fine clastic material, locally with a large percentage of conglomerate. Much of the Kenai can be definitely recognized as of fluviatile origin, and in many places it carries a fresh-water flora. Only on the Alaska Peninsula have marine fossils been found in the formation, and here they are intimately intermingled with plant remains. Much the larger part of the Kenai coal is lignitic, but the high-grade coal of the Matanuska field and possibly part of that of the Bering River field are also of Kenai age. The Bering River coal may be in part of Miocene age; if so, it is the only Miocene coal recognized in Alaska. Some thin beds of lignitic coal that have been found at Yakutat Bay and at various places in the Yukon basin are probably of Pliocene, possibly of Pleistocene age.

The geologic positions of the Alaska coals are summarized in the subjoined table:

Stratigraphic position of Alaska coals.

System.	Series.	Character of coal.	Principal distribution.
Quaternary	Pleistocene	Lignitic	Yukon basin and other parts of Alaska.
Tertiary	Pliocene	do	Yakutat Bay and other localities.
	Miocene or Eocene	Anthracitic and bituminous.	Bering River.
	Eocene	Chiefly lignitic; also some bituminous and subbituminous.	Throughout Alaska, notably on Cook Inlet and in Matanuska Valley, Susitna Valley, and Yukon basin.
Cretaceous	Upper Cretaceous	Subbituminous and bituminous.	Alaska Peninsula, Yukon and Colville basins.
Jurassic		Lignitic, subbituminous, and bituminous.	Near Cape Lisburne and in Matanuska Valley.
Carboniferous	Pennsylvanian	Subbituminous	Yukon River.
	Mississippian	Bituminous	20 miles south of Cape Lisburne.

COMPOSITION OF COAL.

About one-half of the known tonnage of Alaska coal is lignite (see table, p. 54), a little over one-fifth is anthracite and high-grade bituminous coal, and the rest falls into the bituminous and subbituminous classes. It is fair to assume that these ratios will hold for the coals of the areas on which no tonnage estimates are possible.

The anthracite of the Bering River and Matanuska fields is but little below that of Pennsylvania in composition. To judge from the amount of deformation that the rocks in which the beds occur have undergone, it seems probable that much of the anthracite will yield a large amount of slack. It is possible that some of the beds are so crushed as to make it necessary to defer their mining until some method of utilization of the fine coal has been devised. The coals classed as semianthracite are of about the same composition as the Loyalsock or Bernice basin coals of Pennsylvania.

The higher-grade bituminous (semibituminous) coals of the Bering River and Matanuska fields are comparable in composition and heating power with the Georges Creek, New River, and Pocahontas coals of the East. Many of these beds also include a large amount of slack, which may, however, be utilized under boilers or for making coke. The lower-grade Alaska bituminous coals compare favorably in composition with the coals of Japan, Vancouver Island, Washington, and Australia. This is an important point, as these are the fuels with which the Alaskan coal must come into competition.

The following table summarizes the composition of the Alaskan coals:

Analyses of Alaska coals.[a]

District and kind of coal.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
Anthracite.					
1. Bering River, average of 7 analyses	7.88	6.15	78.23	7.74	1.30
2. Matanuska River, 1 analysis	2.55	7.08	84.32	6.05	.57
Semianthracite.					
3. Bering River, average of 11 analyses	5.80	8.87	76.06	9.27	1.08
Semibituminous.					
4. Bering River, coking coal, average of 28 analyses	4.18	14.00	72.42	9.39	1.73
5. Cape Lisburne, average of 3 analyses	3.66	17.47	75.95	2.92	.96
6. Matanuska River, coking coal, average of 16 analyses	2.71	20.23	65.39	11.60	.57
Bituminous.					
7. Lower Yukon, average of 11 analyses	4.68	31.14	56.62	7.56	.48

[a] From Survey publications, as follows:

1. Bull. 335, 1908, p. 84.
2. Bull. 284, 1906, p. 98.
3, 4. Bull. 335, 1908, p. 84.
5. Bull 278, 1906, p. 47.
6. Bull. 284, 1906, p. 98.
7. Bull. 218, 1903, pp. 62-63.

Analyses of Alaska coals [a]—Continued.

District and kind of coal.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
Subbituminous.					
8. Matanuska River, average of 4 analyses	6.56	35.43	49.44	8.57	0.37
9. Chignik Bay, Alaska Peninsula, average of 4 analyses	6.98	30.89	42.88	19.29	1.50
10. Herendeen Bay, Alaska Peninsula, average of 2 analyses	7.75	32.83	50.06	9.26	.36
11. Nation River, Yukon basin, 1 analysis	1.39	40.02	55.55	3.04	2.98
12. Koyukuk River, 1 analysis	4.47	34.32	48.26	12.95	.....
13. Cape Lisburne, average of 11 analyses	9.35	38.01	47.19	5.45	.35
14. Anaktuvuk River, 1 analysis	6.85	36.39	43.38	13.38	.54
Lignite.					
15. Admiralty Island, southeastern Alaska, average of 5 analyses	1.97	37.84	35.18	24.23	.57
16. Port Graham, Cook Inlet, average of 2 analyses	18.41	38.10	35.79	7.69	.40
17. Kachemak Bay, Cook Inlet, average of 10 analyses	20.46	38.77	35.56	10.25	.35
18. Tyonek and Beluga River, Cook Inlet, average of 5 analyses	21.50	37.28	30.60	10.63	.57
19. Unga Island, Alaska Peninsula region, average of 3 analyses	19.09	39.39	26.84	16.83	.94
20. Kodiak Island, 1 analysis	12.31	51.48	33.80	2.41	.17
21. Chistochina River, Copper River basin, 1 analysis	15.91	60.35	19.46	4.28	.....
22. Chitistone River, Copper River basin, 1 analysis	1.65	51.50	40.75	6.10	.....
23. Upper Yukon, Canadian, average of 13 analyses	13.08	39.88	39.28	7.72	1.26
24. Upper Yukon, Circle province, average of 3 analyses	10.45	41.81	40.49	7.27	1.30
25. Upper Yukon, Rampart province, average of 6 analyses	11.42	41.15	36.95	10.48	.33
26. Nenana River, Tanana basin, 1 analysis	13.02	48.81	32.40	5.77	.16
27. Chicago Creek, Seward Peninsula, average of 9 analyses	37.73	24.14	29.27	8.86	.....
28. Wainwright Inlet, northern Alaska, 1 analysis	10.65	42.99	42.94	3.42	.62
29. Colville River, northern Alaska, 1 analysis	11.50	30.33	30.27	27.90	.50

[a] From Survey publications, as follows:

8. Bull. 284, 1906, p. 98.
9, 10. Bull. 379, 1909, p. 146.
11, 12. Bull. 218, 1903, p. 62.
13. Bull. 278, 1906, p. 47.
14. Prof. Paper 20, 1904, p. 114.
15. Bull. 284, 1906, p. 27.
16, 17. Bull. 259, 1905, p. 170; Bull. 379, 1909, p. 126.
18. Bull. 379, 1909, p. 126.
19. Bull. 259, 1905, p. 170; Bull. 379, 1909, p 146.
20. Bull. 259, 1905, p. 170.
21. Prof. Paper 41, 1906, p. 124.
22. Idem, p. 125.
23. Bull. 218, 1903, pp. 61-62.
24. Idem, p. 63.
25, 26. Idem, p. 62.
27. Bull. 379, 1909, p. 363.
28, 29. Prof. Paper 20, 1904, p. 114.

AREAS OF COAL LANDS AND COAL FIELDS.

As only about one-fifth of Alaska has been surveyed geologically, it is evident that any estimate of the area of the coal fields serves only as a measure of the minimum area. With these limitations on the accuracy of the figures the total known coal fields include an area of about 12,667 square miles. It is not impossible that future surveys may prove that the coal fields embrace many times this area. The figures indicate the number of square miles of land which are underlain by the coal-bearing formations. If, however, the estimate is made to cover only the area of actually proved coal lands, namely, those which are known to be underlain by coal beds of a quality and thickness and at a depth that make mining practicable, the figures are only 1,202 square miles. In other words, only about one-tenth of the area of the coal fields is sufficiently well known to be classified as coal land. This is due to the fact that detailed surveys are often necessary to establish the presence or absence of commercial beds of coal. It should be noted that in the above classification only quality, quantity, and depth of coal are taken into account. It is clear that

so far as development is concerned the accessibility of the coal and the possibility of marketing it are just as important as the factors mentioned above in designating commercially valuable coal lands. For example, some of the best coals have no value because they can not be marketed under any demand that can now be foreseen. It is evident, therefore, that the figures presented above have little practical import. They will serve the economist only by indicating the minimum coal-bearing areas which may in the generations to come be drawn upon for fuel.

The general distribution of coal areas in Alaska is presented in the subjoined table, which was compiled by Mr. Martin in 1908. Since this table was compiled some surveys have been made which modify some of the figures presented. As the figures are a mere approximation, however, and as nearly every season's field work yields results bearing on these areas it is impossible to publish an estimate which will have lasting value. It therefore seems best to leave the table as it stands until information is available which will permit more accurate estimates to be made.

Estimate of areas of Alaska coal fields.

[In square miles.]

	Coal lands (areas believed to be underlain by workable coal).	Coal fields (supposed areas underlain by coal-bearing rocks).
Anthracite: Pacific coast	25.8	.....
Semianthracite: Pacific coast	7.2	620
Semibituminous:		
Pacific coast	35.8	.....
Arctic slope	14.2	.....
Total semibituminous	50.0	.....
Total high-grade	83.0	620
Bituminous:		
Pacific coast	2.0	900
Interior region	162.0	2,475
Total bituminous	164.0	3,375
Subbituminous:		
Pacific coast	49.7	657
Interior region	6.0	15
Arctic slope	205.0	1,323
Total subbituminous	260.7	1,995
Lignite:		
Pacific coast	337.0	2,938
Interior region	264.5	2,003
Arctic slope	93.0	1,736
Total lignite	694.5	6,677
Summary by provinces:		
Pacific coast	457.5	5,115
Interior region	432.5	4,493
Arctic slope	312.2	3,059
	1,202.2	12,667

The incompleteness of these figures can best be illustrated by some examples. The Bering River field may be extended into the mountains and have many times its present known area. If the entire eastern and western extensions of the Matanuska Valley are underlain by coal beds, as may be the case, the actual area of this field is many times that used in the present estimate. In the Cook Inlet and Susitna regions the estimates for area are based on a coal field of 30 to 40 square miles. As a matter of fact, it is not improbable that the whole Cook Inlet-Susitna depression may be underlain by coal-bearing rocks at no depth prohibitive of mining. If such is the case, this coal field might possibly embrace 10,000 to 20,000 square miles. There is also good reason to believe that the area of the coal fields of the Arctic slope far exceeds that of all the rest of the Alaskan fields.

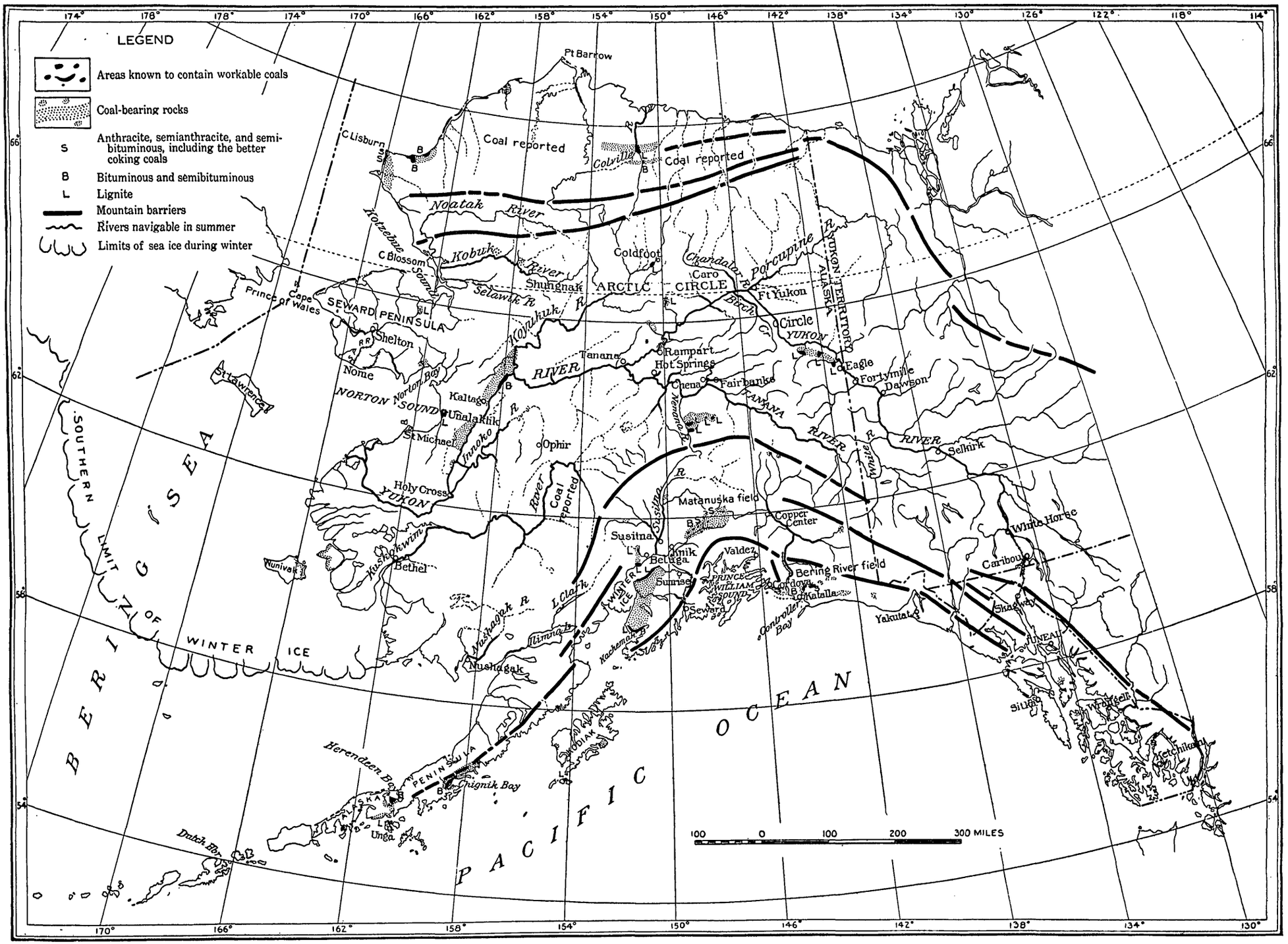
The accompanying map (Pl. I) shows the distribution of the coal, together with symbols indicating its quality. The areas believed to be underlain by workable coal beds are marked in black on the map, and the areas of the coal fields, so far as they are known, are indicated by stippling. Under the first of these two symbols are included only areas in which there is a reasonable degree of certainty that commercial coal beds occur; the second indicates what is known of the probable extension of the coal fields, and hence defines the areas worthy of prospecting. It should be noted that this mapping does not by any means have the same value throughout the Territory, for in some portions it is based on geologic surveys of a high degree of refinement, in others only on hasty observations made during a rapid exploration.

TONNAGE ESTIMATES.

Estimates of Alaska's coal resources, expressed in tonnage, were prepared for the Conservation Commission.[a] Although these figures are of some value to the economist, inasmuch as they serve to indicate the minimum quantity of fuel which Alaska can furnish, yet they do not show the ultimate coal resources of the Territory. The estimates have little bearing on the questions here under consideration, but as they have recently received wide publicity and have to some extent been misinterpreted, it seems best to repeat them and to discuss briefly their significance.

The facts already presented which militate against an accurate statement of the area of Alaska coal lands apply with still greater force to estimates of tonnage. Of the 1,202 square miles classed as coal land, less than one-quarter has been surveyed in sufficient detail to yield any quantitative data whatever. Even where such surveys have been made, a large factor of uncertainty is introduced either by the folded and faulted condition of the coal beds or by the lack of

[a] Rept. Nat. Conserv. Comm., Senate Doc. 676, 60th Cong., 2d sess., vol. 3, p. 581; reprinted in Bull. U. S. Geol. Survey No. 394, 1909, p. 182.



MAP SHOWING RELATION OF ALASKA COAL FIELDS TO TRANSPORTATION ROUTES.

definite knowledge regarding sequence of strata. There must, therefore, be a very large element of uncertainty in the tonnage estimates for even the 300 to 400 square miles of surveyed coal fields. Moreover, in Alaska there are almost no data available from private sources, such as the results of extensive mining or prospecting operations, which form an important element in the estimates made of the coal resources of the States.

The estimates of tonnage given below were made by Mr. Martin on the following basis:

1. No beds less than 3 feet thick were assumed to be workable or contributed to the tonnage.

2. The depth of workability was assumed to be 3,000 feet for the highest-grade coal (anthracite, semianthracite, semibituminous); 2,000 feet for the better bituminous and subbituminous coals, such as those on the lower Yukon, at Cape Lisburne, and on Matanuska River; and 1,000 feet for the poorer subbituminous coals and all the lignites.

3. The tonnage was computed by the formula Tonnage = area of bed to limit of workability (square miles) × thickness (inches) × specific gravity × 72,600.

4. The specific gravity was assumed to be 1.30 for lignite, 1.35 for bituminous, and 1.38 for the high-grade coals.

5. Bering River field: A certain percentage of the coal-bearing rocks is shown by the average sections to consist of workable coal beds; this percentage of the computed bulk of rock to the limit of workability gave the estimated tonnage.

6. Nenana field: As for Bering River, with the necessary change for percentage of coal in rocks.

7. Matanuska field: Each bed was estimated separately according to its average thickness, length on a safe assumption of continuity, and width on the dip to the limit of workable depth.

8. Lisburne field: The Corwin district was computed like the Matanuska, the length of the beds being assumed to be the distance from the shore to the edge of the mapped area. The Beaufort district was assumed to have one-half the tonnage per square mile of the Corwin district.

9. Yukon field: Each bed was figured as in the Matanuska, but the beds were not assumed to extend more than a mile in each direction from the mine or prospect where they had been exposed, except in the Washington-Bonanza district, where a continuity of 50 miles on the strike was assumed.

10. Cook Inlet field: Computed as for the Matanuska.

11. All the other fields were computed on the basis of a most conservative estimate of thickness of coal underlying the field and an area believed to be a safe minimum. In none of the fields was the

coal assumed to go beyond points where it is shown to exist by reliable information from members of the Survey. The areas used in making the last class of estimates are consequently very small and are possibly subject to an immense extension in the light of subsequent information.

Tonnage estimates of Alaska coal lands.

	Short tons.
Pacific coast:	
Anthracite	1,611,700,000
Semianthracite	517,100,000
Semibituminous	1,425,800,000
Total high grade	3,554,600,000
Bituminous	2,600,000
Subbituminous	535,500,000
Lignite	2,173,100,000
Total low grade	2,711,200,000
Total Pacific coast	6,265,800,000
Interior region:	
Bituminous	15,900,000
Subbituminous	59,200,000
Lignite	4,228,000,000
	4,303,100,000
Arctic slope:	
Semibituminous	66,800,000
Subbituminous	3,465,600,000
Lignite	1,003,200,000
	4,535,600,000
Summary by kinds of coal:	
Anthracite	1,611,700,000
Semianthracite	517,100,000
Semibituminous	1,492,600,000
Total high grade	3,621,400,000
Bituminous	18,500,000
Subbituminous	4,060,300,000
Lignite	7,404,300,000
Total low grade	11,483,100,000
Grand total	15,104,500,000

In making these estimates the attempt has been made to err on the conservative side, and thus they represent minimum rather than maximum figures in each case. This may account for the fact that they indicate an average of 20,000 tons to the acre on the Alaska coal lands, as compared with 32,000 tons to the acre in the coal fields of the western public-land States. On the other hand, with the same data for any particular area, the coal estimates of the federal geologist will usually exceed those made by the mining engineer for private interests. The reason for this lies in the fact that the geolo-

gist includes in his estimate all the coal beds of a certain thickness and to a certain depth, for it is his purpose to present figures which shall approximate at least the ultimate coal resources of the district under examination. The mining engineer, on the other hand, is not interested in the ultimate coal recovery but is charged with the duty of estimating the quantity of coal which is either immediately available or can be mined under conditions that will soon arrive. For example, a number of engineers have roughly approximated the coal of the Bering River field at 500,000,000 tons, and these figures have been widely quoted. This estimate, however, includes only the coal lying above water level which can be mined without hoisting. The tonnage estimate of the Geological Survey is many times this figure, because it includes all the coal lying within 3,000 feet of the surface. It should therefore be borne in mind that the two classes of estimates are made with very different purposes and do not admit of direct comparison.

In considering the above table it must be remembered that these estimates cover only the 1,202 square miles of coal lands, namely, that part of the coal fields which, with a reasonable degree of certainty, is believed to be underlain by workable coal beds. No allowance whatever is made for the remainder of the 12,667 square miles, which are mapped as coal fields. The possibilities of finding coal in the unsurveyed districts are also ignored. Evidently, therefore, if the same acre tonnage holds throughout the coal fields, these estimates should be multiplied by ten. Again, the discovery of new coal fields will add to the tonnage. It is therefore probably safe to say that the minimum estimate of Alaska's coal resources should be placed at 150,000,000,000 tons and that the actual tonnage may be many times that amount. These figures indicate coal resources far in excess of the original coal supply of Pennsylvania. It must be remembered, however, that over half the Alaska coal is lignite, while all of the Pennsylvania coal is of a high grade.

THE COAL FIELDS.

SOUTHEASTERN ALASKA.

Though Tertiary (or possibly Upper Cretaceous) coal-bearing terranes are known to cover a considerable area in the southern part of Admiralty Island and are also found on adjacent islands, the included coals appear to have no present importance. These beds are from a few inches to 2 or 3 feet in thickness, and the coal, so far as known, is all of a low-grade lignitic character. A little mining has been done, however, and it is possible that coal may be discovered which could find a local market.

BERING RIVER FIELD.

One of the two Alaskan fields containing the largest known amount of high-grade coal lies about 25 miles northeast of the indentation of the southern shore line of Alaska called Controller Bay. The field is drained by Bering River, from which it received its name.[a] The surveyed parts of the Bering River field embrace about 22 square miles underlain by anthracite and about 28 square miles underlain by semibituminous and semianthracite coal.

The workable coal beds in this field are from 3 to 25 feet thick, but through local swellings a much higher maximum thickness is attained. They are included in a great series of sandstones and shale of Tertiary age (Miocene?), which are intensely folded and much faulted. In quality the coals vary from an anthracite, with 84 per cent of fixed carbon, to a semibituminous, with 74 per cent of fixed carbon. (See pp. 49–50.) The field includes some coking coal. The excessive deformation of the strata has led to the crushing of much of the coal. Very little work has been done in this field, so it is impossible to state the physical condition of the coal below the surface, but it seems likely that many beds will be found to contain a large amount of slack.

The coal-bearing rocks of the Bering River field trend to the northeast into the unsurveyed high ranges, where it is probable that there may be other extensive areas. There is also some fragmentary evidence that coal occurs along the seaward face of the mountains east of the Bering River field. Prospectors report the discovery of coal between Controller Bay and Yakataga. There is also said to be coal on the southwest slope of Mount St. Elias, about 100 miles east of Controller Bay. Mr. Broke, one of a party of mountaineers who attempted the ascent of Mount St. Elias in 1888, makes a number of references to the occurrence of coal in his book[b] which gives an account of the expedition. One locality referred to by him appears to lie northwest of the Yahtse Valley and well up on the slope of the mountains. Another is in the Karr Hills, which are described as being made up of sandstone with great beds of coal. One bed is mentioned which is 6 to 8 feet in thickness, and the coal is said to have been burned in the camp fire. All these facts suggest at least that there may be other coal fields in this region besides that of Bering River. Therefore the areas given above only have value in giving a minimum, for it may prove that the surveyed field is but a small fraction of the total. At the same time it should be noted that, on account of the expense of development, any coal occurring

[a] It is sometimes called the Controller Bay field and sometimes the Katalla field.

[b] Broke, George, With sack and stock in Alaska, London, 1890, pp. 86, 91.

in the high ranges is not likely to be made available until the more accessible fields approach exhaustion or until coal commands a much higher price than it does now.

COPPER RIVER REGION.

Lignitic coal has been discovered at several places in the Copper River basin, but in no great quantities. It is known to occur in the Chitina Valley and also in the Chistochina basin. It is also quite probable that the same coal-bearing beds may occur underneath the heavy covering of glacial gravels and silts. These coals are all believed to belong to the Eocene (Kenai formation). There is little hope of the development of a coal-mining industry in this province, as the fuel is of a poor quality and the beds are not thick. It is possible, however, that some may in time have value for local use.

COOK INLET.

Coal-bearing Tertiary rocks are widely distributed in the Cook Inlet region. They are in most places but little disturbed, though locally considerably folded and faulted. The largest areas of coal-bearing rocks in this field occupy the western part of Kenai Peninsula, and are in part buried under a cover of Quaternary gravels. It is not impossible that the entire Cook Inlet depression may be underlain by these coal-bearing formations. It seems probable that the coal reserves in the Cook Inlet region are very large, for the area of the coal field is estimated at 2,565 square miles.

The best-known part of this field lies adjacent to Kachemak Bay on the north, where 2,000 to 3,000 feet of coal-bearing rocks are exposed. These rocks probably contain an aggregate thickness of over 60 feet of workable lignitic coal beds, the thickest of which reaches about 7 feet. Lignite in workable seams has also been found at Port Graham and Tyonek. The coal thus far found in Kenai Peninsula is all lignite, though but little search has been made, except along the shore line. It is possible that higher-grade coals may occur along the mountain front, where greater deformation may have taken place.

Though Kenai Peninsula was the scene of the earliest coal-mining venture in Alaska (1854), yet the product of the industry has amounted to only a few thousand tons. Coal has been mined at Port Graham, on Kachemak Bay, and near Tyonek. The accessibility of the coal to tide water and the undisturbed condition of the beds make for cheap mining and transportation. With improvement in methods for the utilization of lignites, fuel from this field might yet become a competitor with the fuels of a higher grade. Under present conditions

of utilization, however, this coal can hardly be expected to compete with that of the Bering River and Matanuska fields, except in a very local market.

MATANUSKA FIELD.

The Matanuska coal field shares with that of Bering River the preeminence in the present fuel situation in the Territory. This field lies about 25 miles from tide water at Knik Arm, a northerly embayment of Cook Inlet. As, however, Cook Inlet is frozen during the winter months, the distance to tide water must be measured to the east side of Kenai Peninsula, about 184 miles.[a]

The known commercially valuable coals of the Matanuska are included in folded and faulted rocks of Tertiary (Eocene ?) age, including shales, sandstones, and conglomerates aggregating 3,000 feet in thickness. Coals are also known to occur in a Jurassic formation which is extensively developed in the upper Matanuska basin. These Jurassic coals appear to be chiefly lignitic but may include some of higher grade. Their commercial importance has not been established.

The Tertiary coal-bearing series has been traced for 50 to 60 miles along the Matanuska Valley, but much of it is buried under a heavy blanket of Quaternary gravels. The bituminous coal, which seems to form the main body, appears to pass into a lignite at the west end of the field, while there is some evidence that the same coal is represented by an anthracite near the east end of the belt of Tertiary rocks. This anthracite may, however, belong to the older coal-bearing formation.

The commercial coals of the Matanuska field vary from a subbituminous to a semibituminous, and there is also some anthracite, but of this less is known. It is evident from the facts in hand that there is a large amount of high-grade bituminous coal in this district. The beds vary from 5 to 30 feet in thickness.

So far as at present known, the total area underlain by commercial seams aggregates 46.5 square miles. As much of the field is covered, however, and as it has not been surveyed in detail, the coal-bearing area is probably much larger. The total area of what may prove to be coal-bearing rocks is approximated at 900 square miles.

A railway is in construction which will lead to the opening of this field, and this should result in the development of the high-grade fuels. The lignites of the western part of the Matanuska field will not bear shipment to a distance in competition with those of higher fuel value.

SUSITNA BASIN.

Lignitic coal-bearing rocks have been found in small and widely separated areas in the Susitna basin. There is some evidence that in the lower Susitna Valley there are extensive deposits of this for-

[a] Possibly a summer port of shipment could be established on Knik Arm, 60 miles from the coal field.

mation, now buried underneath a heavy cover of glacial gravels and silts. In any event lignitic coal is known to occur on both margins of the valley. According to reports of prospectors it is best developed along the eastern slope, where there is a belt of Tertiary sediments, which appear to be coextensive with those of the Matanuska Valley. The same rocks occur at the mouth of the Chulitna, where there are beds of lignite from 6 inches to 6 feet in thickness. Under conditions which can now be foreseen these coals are not likely to have value except for local use. It is not impossible, however, that there may be many thousand square miles in this region which are underlain by coal-bearing rocks; if so, this province is an important element in the ultimate fuel resources of Alaska.

ALASKA PENINSULA REGION.

Coal has been found both in Upper Cretaceous and in Eocene formations in the Alaska Peninsula. The developed coals occur in three separate fields—Herendeen Bay, Chignik, and Unga Island—and include both lignitic and bituminous varieties. In addition, lignitic coals have been found in other parts of the peninsula. These coals occur in beds which are either practically horizontal, as at Unga, or thrown into open folds with some faulting, as in the Herendeen Bay and Chignik fields. The proved bituminous coal lands of the peninsula include an area of about 30 square miles; the known area of the bituminous coal-bearing formations is about 90 square miles. The known areas of the lignite-bearing formation amount to about 60 square miles. These figures are, however, not significant, as but a small fraction of the total area of the peninsula has been surveyed. It is quite possible that the total area of the coal fields may amount to many hundred square miles.

In Herendeen Bay field the commercial coal beds measure 2 to 5 feet in thickness, but in the Chignik field they are somewhat thinner. On Unga Island lignite coal beds up to about 3 feet in thickness have been found. Coal has been mined for many years at Chignik, and some has been taken out at Herendeen Bay for local use, but the total output of the peninsula does not exceed 20,000 tons. These coal fields are all readily accessible from good harbors and will form one of the early available fuel assets of the Territory when the demand for coals of this grade warrants their exploitation.

YUKON REGION.

The coals of the Yukon, including some bituminous and subbituminous, together with a large amount of lignite, are for the most part of Tertiary (Eocene?) age. Some of the bituminous coals are probably Upper Cretaceous. There are also some thin coal beds in the

Carboniferous rocks of the Yukon, but these appear to be of no commercial value. The Tertiary lignitic coal beds typically occur in association with conglomerates, sandstones, and shales, usually only little deformed but in places much folded and faulted. The bituminous coals, which are confined to the lower Yukon, occur with finer sediments that have been gently folded and somewhat faulted.

The lignitic coal occurs in beds up to 20 feet in thickness; the bituminous is in beds from 2 to 3 feet thick, and such comparatively thin seams have not encouraged exploitation, especially as they appear not to have much continuity. Therefore, in spite of the high price of mineral fuel in this central region there has been but a small production, and that chiefly for the use of the Yukon River steamers, many of which now, however, burn California petroleum.

Coal-bearing beds are so widely distributed in the Yukon region that it will not be feasible to give an account of all the occurrences. The three largest fields are (1) the Nulato region, (2) the Nenana region of the lower Tanana Valley, (3) the Washington and Coal Creek belt of the upper Yukon. Of these the Nulato field contains the best coal, while the Nenana is the most extensive and has the thickest beds. The total area known to be underlain by coal in the entire Yukon region is about 260 square miles; the coal fields may embrace 2,000 square miles or more.

The Nenana field, being the largest, merits a little more detailed description. It lies 20 to 40 miles south of Tanana River, between Nenana and Delta rivers. It is included in a formation (Eocene) from 500 to 1,800 feet in thickness, which is for the most part only slightly deformed but in places considerably faulted. The coals, which are all of lignitic character, vary from a few inches to 20 feet in thickness. One measured section on Healy Fork showed 60 feet of coal. The total area known to be underlain by coal is 66 square miles, but the coal-bearing strata are exposed in an area of 600 square miles and are known to extend eastward into an unsurveyed area. The Nenana field therefore must include a very large amount of coal.

Some of the lignitic coals of the upper Yukon should eventually find a local market when the scant supply of accessible timber approaches exhaustion. There is a constantly increasing demand for power in the placer districts, and this can only be met either by developing water powers, which are not extensive, or by utilizing the coals. The low fuel values and the cost of transportation of these coals may lead to their transformation into electric power at the mines, to be transmitted to the placer camps. Some of the lignite fields are near enough to the placer fields to permit such utilization.

KUSKOKWIM BASIN AND BERING SEA COAST.

Lignitic coal beds have been reported to occur at various places in the lower Kuskokwim basin, but most of these appear to be too thin and too low in grade to have any commercial value. Similar coal beds occur on the Bering Sea coast near the mouth of the Kuskokwim and on Nunivak, but little is known about them.

It has only recently been brought to the attention of the writer by W. E. Priestley[a] that coal also occurs on the upper Kuskokwim. It appears that this coal formation covers considerable area and that some of the beds are very thick. A specimen of the coal collected by Mr. Priestley shows it to be a good grade of lignite.

SEWARD PENINSULA.

The known coal-bearing areas of Seward Peninsula do not exceed a few square miles. The rocks are probably of Eocene age, and the coal is of a low grade. This coal, however, is important because it can probably be utilized locally to furnish power for mining purposes, instead of the higher-grade coals that are now being brought in from outside sources. There is a little coal in the southeastern part of the peninsula, but it is not believed to be in commercially valuable beds. The important coals are those of Chicago Creek, lying in the northeastern part of the peninsula. Here a lignitic coal bed has been opened which is over 80 feet in thickness, with only a few thin partings of bone and shale. Two small coal mines are being operated in this district, and their product is marketed at the near-by placer camps and is competing with higher-grade fuels transported from a distance. In considering the value of this coal it should be noted that most of Seward Peninsula is without timber, and that all mining operations must therefore depend on imported fuels or draw on this local supply of lignite.

NORTHERN ALASKA.

Geographically the known coal fields of northern Alaska fall into three groups—those of (1) Cape Lisburne, (2) the Colville basin, (3) Wainwright Inlet. Coal has also been found on Kobuk River and is reported to occur between these areas, as well as east of Colville River. The Cape Lisburne field includes the Corwin and Cape Beaufort districts.

Three coal-bearing formations are recognized in this northern field—(1) the Carboniferous Lisburne formation (Mississippian?), made up of slates, shales, and limestones, with some high-grade

[a] Mr. Priestley made a winter trip from the Innoko to Seward in 1909. In the course of his journey he explored the basin of Big River, a southerly tributary of the Kuskokwim near the forks, where he found the coal.

bituminous coals, and having a thickness of 500 feet or more; (2) the Jurassic Corwin formation, including at least 15,000 feet of shales, sandstones, and conglomerates and containing a large number of subbituminous coal beds; (3) the Tertiary Kenai formation (?), made up of conglomerates, sandstones, and shales, with lignitic coal seams. The two lower formations are closely folded and faulted; the Tertiary beds are, as a rule, only little disturbed.

In areal extent, quantity, and quality of coal the Cape Lisburne field is the most important in northern Alaska. It includes the high-grade bituminous coal of Carboniferous age (Cape Beaufort district), which varies from 1 to 5 feet in thickness. An area of 14 square miles is known to be underlain by this coal, but the actual size of the basin is probably much larger. In the Corwin district, embracing the subbituminous Jurassic coals, there are beds up to 12 feet in thickness. The actual area known to be underlain by commercial coal beds in this district is over 200 square miles, while the coal-bearing formation, as roughly outlined, embraces over 1,200 square miles. This is the most extensive coal deposit which has been found in Alaska.

The total area in northern Alaska known to be underlain by coal aggregates 302 square miles, and the coal fields, roughly outlined from the data in hand, include some 3,000 square miles. The scant evidence available points to the conclusion that a survey of this northern region will show very large coal fields in this part of Alaska.

A little coal mining for local use has been carried on in the bituminous field near Cape Lisburne and in the lignitic field of Wainwright Inlet, but the region as a whole is practically untouched. It is certain that there will be no extensive mining in this northern field for many generations to come. These coals appear to be too inaccessible to invite exploitation, except for the local use of whalers and natives, under any demands that can now be foreseen. The chief difficulties in attempting to ship out this coal by vessels are, first, the lack of harbors, and, second, the fact that the open season for navigation is less than two months.

MINING DEVELOPMENTS.

Though something has been known of Alaska coal for more than sixty years, the amount of actual mining has been insignificant. The total production since the Territory was acquired from Russia is less than 50,000 tons. This is all the more significant because during this time more than a million and a half tons of coal have been shipped to Alaska, all but about 20 per cent of which was brought from foreign fields.

The following table shows the annual coal production since 1897 and an estimate of the output between 1888 and 1897. A little coal was mined previous to 1884 by the crews of vessels that ran short

of fuel, but this probably did not aggregate more than a few hundred tons. The total output of coal previous to 1889, including that mined by the Russians, was probably less than 10,000 tons.

Production of coal in Alaska, 1888–1909.

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	3,107	14,810
1901	1,300	15,600	1909	2,800	12,300
1902	2,212	19,048			
1903	1,447	9,782		43,414	323,189

NOTE.—The production for 1888–1896 is estimated on the best data obtainable. The figures for 1897 to 1908 are based for the most part on data supplied by operators; those for 1909 on preliminary estimates.

Several of the first explorers of the Alaska coast noted the presence of coal on Cook Inlet, where, too, the first attempts at mining were made. In 1854 an American company [a] under a Russian charter opened a coal mine at Port Graham, on Cook Inlet, and this mine continued to supply Russian steamers with fuel until the transfer of the Territory. The demand for fuel due to the rapid increase in the population of California was the first incentive to a systematic search for coal in Alaska. In the early seventies coal lands were staked on Unga Island, and during the next thirty years a number of companies were organized for the purpose of exploiting the coal of Cook Inlet and the Alaska Peninsula region. Up to 1896, however, nothing notable was accomplished either in mining or in prospecting, though some mining had been done at Kachemak Bay, Chignik, and Herendeen Bay, on Admiralty Island, and along Yukon River. Coal mining lagged in Alaska chiefly because the Pacific coast markets were supplied from the rapidly developing fields of Washington, California, and Vancouver Island.

It appears to have been about 1896 that the Bering River field first attracted the notice of prospectors, and about two years later the Matanuska field was also found. By 1901 prospectors had begun to recognize the importance of these two fields. It was not, however, until after the examination and reports by the Geological Survey (1904–1908) that the public outside of Alaska began to realize that these fields contained a large quantity of high-grade fuel.

Meanwhile the exodus to Alaska which took place from 1897 to 1900, because of the placer-gold discoveries, had much increased the local demand for fuel. Several mines were then opened on the Yukon, intended to supply coal to river steamers. Most of these enterprises were abandoned when petroleum engines were substi-

[a] This company was first organized to supply ice to California from Alaskan glaciers.

tuted for coal burners in 1902. An enterprise which had for its purpose the shipping of coal to Nome from the Cape Lisburne fields was equally unsuccessful. More important was the opening of a coal mine on Chicago Creek, in the northeastern part of Seward Peninsula. This mine began to supply the neighboring placer camps with fuel in 1903 and has been in operation every winter since that time. A second mine was opened in 1909. These enterprises indicate the value of the lignite deposits for local industries. Mining in a small way has also continued to the present day at several localities on the Pacific seaboard, and more intermittently on the Yukon and at Cape Lisburne. In 1906–7 a few thousand tons of coal was mined on Bering Lake, being used in the railway construction work of the vicinity. This is the only mining that has been done in either of the two most important coal fields.

Two influences have held back the development of the Bering River and Matanuska fields. One was the advances made in the California oil districts, and the other the unfortunate conditions existing in regard to the laws under which Alaska coal lands can be taken up.

During the decade ending with the year 1908 the annual output of the California oil fields increased from about 2,500,000 to nearly 45,000,000 barrels. As probably 80 per cent of this petroleum is used for fuel in the Pacific coast States, it has to a corresponding extent decreased the demand for coal.

A far more serious handicap has been the coal-land laws. Though laws intended to enable the individual to obtain title to coal lands have been on the statute books for the last decade, not a single acre of land has yet (July 1, 1910) gone to patent. It is therefore not surprising that progress has been checked in the coal fields and that many who would undertake their development have become discouraged.

The first act, passed June 6, 1900, simply extended to Alaska the provisions of the coal-land laws in the United States. This law was ineffective, for it provided that only subdivided lands could be taken up, and there were then no land surveys in Alaska. The matter was rectified by the act of April 28, 1904,[a] which permitted unsurveyed lands to be entered and the surveys to be made at the expense of the entrymen. Unfortunately, the law provided that only tracts of 160 acres could be taken up, and no recognition was given to the fact that it was impracticable to develop an isolated coal field requiring the expenditure of a large amount of money by such small units. Many claims were staked, however, and surveys were made for patents. It was recognized by everybody familiar with the condi-

[a] A complete statement of the Alaska coal-land situation is contained in the testimony of Frederick Dennett, Commissioner of the General Land Office, in hearings before the Committee to Investigate the Interior Department and Forest Service, vol. 5, 1910, pp. 4298–4391.

tions that after patent was obtained these claims would be combined in tracts large enough to assure successful mining operations. No one experienced in mining would, of course, consider it feasible to open a coal field on the basis of single 160-acre tracts. The claims for the most part were handled in groups, for which one agent represented the several different owners. Unfortunately, a strict interpretation of the statute raised the question whether even a tacit understanding between claim owners to combine after patents had been obtained was not illegal. Remedial legislation was sought and enacted in the statute of May 28, 1908. This law [a] permitted the consolidation of claims staked previous to November 12, 1906,[b] in tracts of 2,560 acres. One clause of this law invalidated the title if any individual or corporation at any time in the future owned any interest whatsoever, directly or indirectly, in more than one tract. The purpose of this clause was to prevent the monopolization of coal fields; its immediate effect was to discourage capital. It was felt by many that this clause might lead to forfeiture of title through the accidents of inheritance or might even be used by the unscrupulous in blackmailing. It would appear that land taken up under this law might at any time be forfeited to the Government through the action of any individual who, innocently or otherwise, obtained interest in more than one coal company. Such a title was felt to be too insecure to warrant the large investments needed for mining developments.

The net result of all this is that no titles to coal lands have been passed. Meanwhile, a popular clamor has been raised indiscriminately against all Alaska coal claimants. The practice of locating coal lands through power of attorney, which is strictly legal and universally accepted in all mining law, has been confused with the so-called "dummy entrymen" practice, which is illegal. It is true that many of the coal-land claimants are nonresidents, yet this is necessarily so, for the man who has the means necessary to provide for a survey, payments to the Government, and the development work on a claim required before patent is issued usually does not follow the vocation of a prospector. The difference between the mining of coal and the mining of placer gold has not always been recognized. A placer claim may yield a profit to the prospector who has but a supply of provisions and a few simple tools, but as a necessary preliminary to coal mining at least several thousand dollars must be expended on each claim. Even after the money necessary to patent has been spent, no profit from mining can accrue until sufficient capital has been invested to provide equipment and transportation facilities. These explanations, obvious to every coal miner,

[a] See opinion of the Attorney-General, dated June 12, 1909, expressed in letter to the Secretary of the Interior, Senate Doc. 248, 61st Cong., 2d sess., 1910.

[b] All coal lands of Alaska have been withdrawn from location and entry since November 12, 1906.

are made here because an idea seems prevalent that any individual prospector, after staking a coal claim, can proceed to develop it at a profit as he might a gold placer.

GEOGRAPHIC CONTROL OF THE DEVELOPMENT OF THE COAL FIELDS.

Two great series of ranges,[a] the Pacific mountain system on the south and west and the Rocky Mountain system on the north and east, traverse Alaska and divide it into three general geographic provinces. The southernmost of these provinces, here called the Pacific slope, is divided from a second province, called the central region, by a series of snow-covered ranges. This central region is separated from the third province, called the Arctic slope, by a second mountain barrier. The Pacific slope province includes the watersheds of all the streams flowing into the Pacific Ocean, and therefore a considerable part of the southern mountain system. The Pacific seaboard, except for the upper part of Cook Inlet, is open to navigation throughout the year. (See Pl. I.) A number of transverse valleys and low passes break the continuity of the southern mountain barrier and thus afford routes of approach to the central region. Yukon and Kuskokwim rivers, which drain the central region, are, together with their tributaries, navigable for thousands of miles, but only for the summer months. The Arctic slope is accessible along its seaboard only for a part of the summer. While the mountains which bound it on the south are broken by many passes, railway connection with an open port on the Pacific will not be commercially practicable under any conditions that can now be foreseen. Evidently, then, geographic and climatic conditions have a dominating control of the utilization of Alaska's mineral fuel. In considering the use of Alaska's coal it is therefore necessary to take into account the distribution of the fields with reference to these conditions. By this means it can be determined which coals are available for present use and which are locked up by natural conditions until such time in the future as the price of fuel may make it commercially possible to bring them to market.

It is evident that the coals of the Pacific slope province are at present of most importance. These include the lignitic or bituminous coals of southeastern Alaska, Cook Inlet, the Susitna basin, and the Alaska Peninsula, as well as the high-grade fuels of the Bering River and Matanuska fields. About 40 per cent both of the area known to be underlain by coal and of the estimated area of the total coal fields of the Territory falls in this province. It includes also at least 90 per cent of the known bituminous and higher-grade coals of the Ter-

[a] The axes of the ranges are indicated on the accompanying map (Pl. I).

ritory. In considering this percentage of total coal area it should be noted that this is the best-known part of Alaska, and there is, therefore, less likelihood of future discoveries of coal in this province than in the less explored districts of central and northern Alaska. However, as over 50 per cent of this province is geologically almost unknown there is every reason to believe that future surveys may lead to the discovery of other coal-bearing areas.

The central province includes some bituminous and subbituminous coals on the lower Yukon, besides more extensive areas of a lignitic coal-bearing formation in the upper Yukon basin, notably in the Nenana basin and near the coast line of Bering Sea and elsewhere. About 35 per cent of the total known coal-bearing area falls in this province, and about 36 per cent of the estimated coal fields. At least 80 per cent of the central province, however, is almost unknown, so it is likely that further discoveries of coal will there be made. With this province should be grouped some coal reported to have been discovered in the upper Kuskokwim basin.

The northern region includes the bituminous and subbituminous coals near Cape Lisburne, as well as lignitic and bituminous coal-bearing rocks in the Colville basin and the lignitic coal of Wainwright Inlet. These fields aggregate about 24 per cent of the total of the Territory, and the area known to be underlain by coal forms about 25 per cent of the total. These percentages of total areas are very large considering the fact that only about 10 per cent of the entire province has been studied geologically. There is every reason to believe that very extensive coal fields exist in this part of Alaska.

The coals of the Arctic slope lie north of the Arctic Circle and are not available for export under any demand that can now be foreseen. To transport these coals to any large market, unless during the brief open season of navigation, would necessitate the construction of a thousand miles of railway, much of it through a region without resources. This is, of course, commercially impracticable. Some of these northern fields can find a very restricted local market along the seaboard in supplying whalers and other vessels. It may be possible to supply the Nome market from the Cape Lisburne field, but attempts to do this in the past have not met financial success. These northern fields for the most are of no present commercial importance and must be regarded solely as forming a part of the ultimate coal resources of the world.

Much of the coal of the central province is almost equally unavailable for export under present methods of utilization. It is chiefly lignite and is, therefore, not suitable for transportation to the seaboard, a distance of 400 to 600 miles. In the absence of extensive forests these coals will in time, however, have great value for local consumption. The estimated 4,000,000,000 tons of this coal, aside

from any additional discoveries in the central region, will supply any probable local demand, especially considering the fact that the extensive peat deposits of the region are also a possible source of fuel.

It has been shown that the coal fields of northern and inland Alaska have no value except for local use. There remains, therefore, only the coals of the Pacific slope for which an export coal trade can be expected to develop. The known coal lands within these fields contain, according to the estimates (p. 54), over 6,000,000,000 tons of coal, of which 3,500,000,000 tons is of high grade. If the same ratio between tonnage and area holds in the unsurveyed fields, these figures should be multiplied by 10. It is probably safe to say that these fields contain 50 to 60 billion tons of coal and possibly much more.

The Cook Inlet fields, as well as those of the Alaska Peninsula, lie on or close to tide water and, indeed, for the most part have good harbors, which are ice free throughout the year. These fields are admirably located as regards transportation; but unfortunately their coal is for the most part not of a quality to assure successful competition with other coals tributary to the Pacific Ocean. A few mines have been opened and have found a small local market; but the attempts at export have not met with success. Considering the comparatively high cost of mining and the expense of export on account of lack of return freight, it is not to be expected that these coals can for the present compete in the west-coast market.

On the other hand, the Bering River and Matanuska fields furnish the only known source of high-grade fuels near either the eastern or the western shore of the Pacific Ocean, unless such fuels may be had from the inland coal fields of China. They have, therefore, a great importance to industries of the Pacific coast. From them must come the high-grade steaming and coking coals and anthracite needed by the growing population of the Pacific seaboard States. Unless they are utilized the manufacturing and smelting industries and the navy must depend largely on foreign fuels, except as coal may be brought around Cape Horn or until after the completion of the Panama Canal. Alaska's own need for high-grade coal can be supplied only from these two fields, unless it is furnished by such foreign fuel as is transported for a thousand miles or more.

Railway construction is necessary before the Bering River and Matanuska coals can be brought to tide water. (See pp. 73–76.) The lack of railways is one of the causes which has delayed the development of these coals, as a large investment of capital is necessary before any returns can be expected. Moreover, it increases the cost of the product and places the coal at a corresponding disadvantage with that of such fields as those of Vancouver Island, New South Wales, and some of China and Japan.

COST OF MINING AND MARKETING.

GENERAL CONSIDERATIONS.

With regard to operating costs and markets Alaskan coal fields may be divided into two groups. One includes the lignitic and other coals of inland and northern Alaska which have no value for export and can be mined only for local use. The other includes those coals which lie near enough to the open ports of the Pacific to warrant the belief that they may be mined for export from the Territory. Mining costs are not all-important to the fields of the first group, whose product will not be marketed in competition with that of fields more favorably situated; in other words, the selling price will be determined entirely by the local demand and supply. The cost of mining in these isolated fields will depend on their location, the labor supply, etc., and needs no special consideration here.

On the other hand, the price at which the coals of the Pacific slope can be mined and marketed is of prime importance. Their product, outside of, say, 120,000 tons,[a] which will more than supply the present local needs, must seek a market in the Pacific coast States, where it will be in direct competition with the coals of British Columbia, Washington, and even Japan and Australia. As the export of the lignitic coals, even from the fields which are on tide water, does not seem commercially feasible under the present demands for fuel, these need not here be considered, and the whole question of mining costs resolves itself into a consideration of those in the Bering and Matanuska fields.

Coal mining in the fields of the Pacific slope of Alaska presents no problems which have not been solved elsewhere. This is equally true of transportation, for no serious physical obstacles have to be overcome in building railways from the coal fields to open ports. The whole question of placing Alaska coal on the market in competition with that from other fields depends, then, on relative cost of production. This, of course, means not only the cost of actual mine operations, but also the interest and other overhead charges. These costs will, for a time at least, be greater than those for mining and marketing coal in the States similarly located with reference to water transportation and distance from points of consumption. It is certain that until a large industry is established the miners' wages will be higher than in the States. With the influx of a permanent mining population, however, wages will gradually adjust themselves and there is no reason why they should continue on a much higher scale than, for example, in the coal fields of Washington or Montana. It is a significant fact that in 1909 the wages of miners

[a] Short tons are used in this paper unless otherwise stated.

in the lode districts along the Alaska seaboard averaged only about 10 per cent higher than those of coal miners in the State of Washington. Mr. Storrs,[a] a well-known mining engineer, estimates the cost of miners' wages in the Bering River field at 82 per cent of the total cost of mining coal, including the overhead charges. This is only about 6 per cent higher than the average percentage for the coal fields of Washington and Montana. There can be no doubt, however, that pioneer operators will have to stand a high charge for labor until conditions have adjusted themselves. When continuous employment is assured in the Bering River and Matanuska fields economic laws should act to make the wage scale about the same as in Washington. This is evident from the fact that after the railways necessary to coal development have been constructed a miner can be transported from Puget Sound to the Alaskan fields in a few days and at no great cost.

What has been said of labor is also true of supplies and material. In the early stages of development these will be expensive, but the improvement of means of transportation and the general industrial advancement will lower this cost. When the coal fields have been opened on a large scale, supplies and material should be had at the same cost as in the States plus the ocean and railway freight charges, which ought to be low.

The initial expense of installation of mining plants and transportation systems will be large as compared with similar enterprises in the coal fields of the Western States. There are no data which will make it possible to express definitely the ratio of costs between a mining plant in Alaska and one in the States. Probably most engineers would regard it as unsafe to estimate the increased cost in Alaska as less than 20 per cent, and possibly it would be as much as 50 per cent. As a consequence of the larger initial investment, interest charges will be higher than for plants of the same size in more accessible regions. This interest will remain a fixed charge against the cost of mining during the life of the plant, and will not be subject to reduction by improvements of economic conditions, as will the cost of labor and supplies.

In spite of their northern latitude, the climate[b] in these fields is no more severe than in some of the productive fields in the States. In fact, it can be definitely stated that mining operations will be but little hampered by the climatic conditions. It is possible, however, that snowslides may have to be guarded against in some localities,

[a] Storrs, A. H., Report on the Cunningham coal lands and Bering River coal field, November, 1907: Hearings before Joint Comm. to investigate Interior Dept. and Forest Service, March 26, 1910, pp. 2326–2345.

[b] The annual precipitation in the Bering River field is probably between 120 and 140 inches; in the Matanuska field, about 25 to 40 inches. In the Bering River field the average temperature during the three winter months is about 30° F.; during the summer months, about 51° F. The records in the Matanuska field are very imperfect, but the summer temperature is higher and the winter temperature lower than in the Bering River field.

and the excessive rainfall of the Bering River field may interfere somewhat with outdoor work. The operating costs of the railways tapping these two fields will be enhanced by the heavy snows in and along the front of the coastal ranges, which probably average 8 to 12 feet annually.

BERING RIVER AND MATANUSKA FIELDS.

To forecast the probable market for the Bering and Matanuska coal it will be necessary to make an estimate of the cost per ton delivered at point of consumption. It has been shown that although if either of these two fields were on a productive basis a considerable local market could be found for the output, yet in view of the heavy investment necessary in railways and equipment this local demand would not be sufficient to assure commercial success to the enterprise. In other words, the coal must be delivered in the markets outside of Alaska in competition with that of other fields. Mining and transportation costs are therefore of vital interest to the industry.

The subject of costs is so complex and there are so few reliable data bearing on it that any estimate at present must be regarded as little more than an approximation. Probably no two mining engineers would agree on an estimate of the cost of mining a ton of coal in Alaska and delivering it in the west-coast market.

It is therefore with much hesitancy that the writer presents figures which are based largely on an office study of the problem and to which exception will undoubtedly be taken by men who have had a large practical experience in coal-mining operations. A full statement of the basis of the figures will be given, so that the reader may put his own interpretation on them, and it is hoped that they will at least serve as an approximation. It can not be too strongly emphasized, however, that a difference of, say, 10 cents in the cost of delivering a ton of coal at the point of consumption may mean the difference between success and failure. In other words, the operator under the strong competitive conditions which will exist may have to content himself with as low a profit as 10 cents a ton, the approximate average on bituminous coal mining in the States.

As there has been practically no mining of Alaska's high-grade coals, there is little exact information on which to base estimates of operating costs. Therefore the only way to arrive at such costs is to estimate them on the experience gained in the developed fields of the States. It will simplify this discussion to limit it chiefly to the Bering River field, which is better known than the Matanuska field. The conditions in both fields are in many ways similar except as regards distance to tide water. If anything, the Matanuska field will probably have a little advantage in the actual cost of mining, for its coal beds seem to be somewhat less disturbed than those of the

Bering River field. This will, however, be more than offset by the extra railway haul, amounting to about 130 miles. The Matanuska field, again, appears to have the advantage in having a greater percentage of high-grade coking coal, an important matter where there is liable to be a large proportion of slack, which has far less value than lump coal, unless it can be utilized for making coke.

The cost of mining the Bering River coal will probably be greater than that of mining in the Washington fields, which averages about $1.90 a ton, including labor, supplies, and all fixed charges. According to the census figures of 1902, the cost of coal mining in Washington varied from an average of $1.26 a ton in the Roslyn field to $2.16 a ton in the Carbon River field. The maximum and minimum costs, of course, lie above and below these figures, which are averages of districts. These figures are based on statistics gathered eight years ago, and since that time there may have been some improvements in methods of mining and economies by reason of larger operations. On the other hand, wages have increased about 25 per cent and there has also been an increase in the cost of supplies. It is not likely, therefore, that total mining costs have materially changed.

The difference in mining costs between the Roslyn and Carbon River fields appears to be largely due to the disturbed condition of the beds in the latter. It is also chargeable to the fact that the operations in the Roslyn field are on a larger scale than those in the Carbon River field. Many of the coal beds in the Bering River field may be as much folded and faulted as those in the Carbon River field, and hence it does not seem probable that the cost of mining will be very different except as influenced by the price of labor and supplies. Therefore it will probably not be safe to place the cost of mining, including fixed charges, in the Bering River field at less than $2 a ton. It is true, however, that in the Bering River, as in other fields, there are some coal beds which can be mined for much less than others, and this price is intended to represent an average.

It is of interest to note that Mr. Storrs in the report cited estimates the cost of mining in the Bering River field, including all fixed charges, at $1.93 to $1.96 a ton. Stephen Birch, on the other hand, in his testimony before the joint committee, estimated the cost of mining at $1.75 a ton, and it appears that he also included in this all fixed charges. In presenting the case of Alaska coal miners before the Interior Department, Falcon Joslin [a] placed the cost of mining at $2 a ton. The consensus of opinion, therefore, seems to be that the coal can be mined at a cost between $1.75 and $2 a ton.

It would be of interest to compare these figures with the cost of mining in the Vancouver Island collieries. Unfortunately no state-

[a] Senate Doc. 248, 61st Cong., 2d sess., 1910, p. 200.

ments of the cost of mining in these fields have been published. The writer has been advised, however, that the cost is between $2 and $2.50 a ton. It is probable that these estimates include something for transportation, though this item probably does not exceed 10 or 20 cents. These costs seem abnormally high, as the wage scale is somewhat lower than that of the Washington fields and the coals are certainly less disturbed than those of the Carbon River district.

This estimate of $2 a ton refers to the bituminous coal and is intended to include all operating expenses, such as labor and supplies, as well as interest and other overhead charges. Anthracite mining, including breaking and sizing, will probably be more expensive. Finlay [a] has estimated the cost of anthracite mining in Pennsylvania at $1.29 a ton for run-of-mine coal and at $1.93 a ton for coal actually marketed. Of this amount about 40 cents represents the cost of breaking the coal after it is mined. The average cost of bituminous-coal mining in Pennsylvania is estimated by Finlay at $1.03 a ton. In other words, in Pennsylvania the anthracite costs about 60 per cent more per ton f. o. b. than the bituminous coal.

These ratios between the cost of bituminous and that of anthracite mining are not likely to hold in the Bering River field. It is true, however, that the anthracite coal occurs in the most complexly folded part of the field, and that the cost of mining, including sizing, will therefore probably average higher than that for the bituminous coal. It is evident that the percentage of culm will be an important factor in anthracite mining. The slack coal can in part be used as fuel at the mine, but this will not consume more than 10 per cent of the gross output. Unless, therefore, some market can be made for the culm by briquetting or otherwise it will be wasted and thereby increase the cost of the coal actually marketed.

The cost of transportation, the second large item, is even more difficult to determine than that of mining. Transportation cost can be conveniently divided into three items—(1) railway rate to tide water, including loading charges; (2) ocean freight [b] to Puget Sound or other ports; (3) unloading charges. For the purpose of this discussion only the Bering River field will here be considered, but the same figures should apply to the Matanuska field by adding the additional amount necessary for the longer railway haul. There are two general projects for reaching the Bering River field by railway; one contemplates the extension of a branch line from the nearest point on the Copper River and Northwestern Railway to the coal field, using Cordova as a terminal. The mileage of such a railway by the shortest route, via Lake Charlotte, would be about 58

[a] Finlay, J. R., The cost of mining, New York, 1909, pp. 77-78.

[b] It has been noted that there is some market for the coal in Alaska, but not sufficient to warrant development on a large scale.

miles,[a] of which 25 would be the branch line and 33 over the main line already constructed. The other plan is to build directly from Controller Bay, a distance of some 27 miles to the coal field. For the purpose of this discussion the cost of shipment via the longer route will be emphasized, as giving probably a maximum cost. It should be noted, however, that the longer railway haul to Cordova may in part be offset by the additional investment necessary for providing terminal facilities at Controller Bay. Recent soundings by the Coast Survey,[b] however, have revealed a deep-water channel extending into Controller Bay between Wingham and Kanak islands. This channel is protected from the ocean by Kayak, Kanak, and Wingham islands and Okalee spit. It has been said by some who are opposed to the route that during some of the winter months slush and ice might interfere with the shipping. Be this as it may, it remains to be proved that any disadvantages are sufficiently serious to offset the 30 miles extra haul to Cordova. In any event the possibilities of shipment through Controller Bay must be taken into account in estimating the costs of transportation.

In attempting to estimate the cost of this 58 miles railway haul to Cordova, many difficulties are encountered. One unknown factor is the tonnage which should be assured. Obviously a large tonnage will reduce the cost per ton-mile. Most of the available figures on cost of railway transportation of coal are for lines which handle many millions of tons annually. The average cost on bituminous coal in the States is about 7 mills per ton-mile, but this figure is clearly not applicable to a short line like that under discussion, with a comparatively small tonnage and heavy operating expenses. It would be equally misleading to use the maximum freight rates per ton-mile in the States, which are as high as 3 to 4 cents. Another uncertain factor in considering the Cordova route is the question how to proportion the charge between the main line and the coal branch, and hence to determine whether the expense of the bridge across Copper River must be a charge on the coal tonnage.

As at best, however, the figures can only be approximate, it will serve the purpose of this discussion if certain assumptions are made. It will be assumed that during the first ten years after the railway is completed an average of 1,000,000 tons of coal will be hauled over the railway annually. Furthermore, it will be assumed that the cost over the branch line, which must be supported by the coal traffic, will be 2 cents a ton-mile and over the main line 1 cent a ton-mile. This will give an average of 1.43 cents a ton-mile for the entire distance, or 83 cents for the railway charge to Cordova. As these estimates are only approximate, the railway haul including the loading

[a] One of the surveyed routes has an estimated distance of about 85 miles.

[b] Chart of Controller Bay, Coast and Geodetic Survey, No. 8513, edition of March, 1910.

at Cordova will be put in round numbers at 85 cents. If Controller Bay is used as a harbor and is available for use the entire year, the same rates per ton-mile will make the cost of haulage to tide water 54 cents, to which should be added say 12 cents [a] a ton for extra charges on loading, because of the more expensive ocean terminal.

The freight rate to Seattle is assumed to be 85 cents a ton. This is probably low for a production of only 1,000,000 tons, for it can be obtained only by providing a fleet of colliers. The distance from Seattle to Controller Bay is about 1,200 miles; to Cordova about 1,350 miles. Freight rates on iron ore from the head of Lake Superior to Ohio ports, a distance of about 1,000 miles, varied from 75 cents a ton in 1907 to 65 cents in 1909. On the lakes the ore carriers are laid up about four months in the year, whereas the Pacific ports of Alaska are open throughout the year. Moreover, the lake ore carriers have the delay of passing through the St. Marys canal. On the other hand, they carry down annually nearly 40,000,000 tons of freight and also have return cargoes of several million tons. The freight on coal from the Nova Scotia fields to New England ports, a distance of 800 to 900 miles, is 75 cents a ton. Alaska coal carriers could not count on any return freight. Therefore a freight rate of 85 cents a ton is probably not too high. The charges for unloading are assumed to be 15 cents a ton.

These estimates have included only the profit on the transportation and not that of the coal-mine operator. The average profit in bituminous-coal mining in the States is about 10 cents a ton. Considering that Alaska is a new and undeveloped field it is not likely that capital would be attracted by so low a profit; this is therefore here estimated at 25 cents a ton.

Estimated cost per ton of mining and shipping Bering River coal.

	Via Controller Bay.	Via Cordova.
Mining, including overhead charges	$2.00	$2.00
Freight to tide water and wharfage	.66	.85
Ocean freight to Seattle	.85	.85
Unloading charges	.15	.15
Profit to coal-mine operator	.25	.25
	3.91	4.10

If the Matanuska coal proves cheaper to mine, as may be the case because it appears to be less folded and faulted, a corresponding saving should be made. On the other hand, the railway haul is some 125 to 160 miles longer than that from the Bering River

[a] This figure is obtained by estimating the cost of the terminal at Controller Bay as $1,000,000. The interest charges on this amount at 5 per cent would be $50,000. The cost of upkeep and depreciation in value are assumed to amount to 7 per cent, or $70,000, making $120,000 in all, or 12 cents a ton on a million tons of coal.

field, and this item, even at a much lower rate than has here been considered, will add considerably to the cost of coal at tide water. It is probably conservative to add at least $1 a ton for the cost of the Matanuska coal delivered at Puget Sound.[a] It has been shown that the cost of mining and preparing anthracite for the market will be greater than for the bituminous coal. If this assumption is correct the Bering River anthracite might be put, delivered at Seattle, at a cost of, say, $5 a ton.

According to the above figures the Bering River bituminous coal should be delivered at the wharf in Seattle at $3.91 to $4.10 a ton and the anthracite from the same field for, say, $5. The Matanuska bituminous coal might be delivered at Seattle for $5.[a] These coals can probably be delivered at Oregon and California ports at an additional cost of not more than 50 cents a ton.

These figures are based on an assumed annual shipment of 1,000,000 tons. It does not seem likely that the long haul from the Matanuska field could be profitably maintained at the low mile-tonnage rates here used, unless the amount of coal shipped were very much larger or the railway were maintained by other business. If two competitive roads are constructed in the Bering River coal field the freight rate might be less than that here used. On the other hand, an annual business of 1,000,000 tons could hardly support two railways, let alone three. This explanation is made so that the writer may not be credited with the opinion that the haulage of a million tons of coal can support several hundred miles of railway. A million tons has been used as a convenient figure and because it seems the maximum of coal which the present west-coast market can absorb. (See pp. 94–95.)

With the increase in population and the industrial advancement of the Pacific coast province there will be a constantly growing market for the high-grade fuels which Alaska can supply. It is to be expected that this demand will so increase that in time three railways can be profitably maintained. When this time comes, competition will bring about economies in transportation and possibly in mining, which will in turn extend the market for this coal. The percentage of slack coal produced which is less valuable for steam and unfit for domestic use is another important element to consider in this connection. This slack coal could be used for making coke if there were sufficient market for the output. If, however, the slack is in any sense a waste product, it might enhance the cost of the salable coal to the point of seriously curtailing the market. A determination of the percentage of fine coal can be made only after actual mining has begun, and even then it is likely to vary from place to place and from bed to bed.

[a] If a summer terminal can be established on Knik Arm (see p. 58) transportation charges will be less.

VALUE OF ALASKA COAL LANDS.

Though the valuation of the Alaska coal lands is rather outside the scope of this article, yet it will be briefly considered, both because it has recently attracted widespread interest and because it is a subject about which many misconceptions are current. The broad economic fact of the ultimate value to future generations of all the Alaska coal fields is not open to argument. At some distant time in the future, when the more accessible coals approach exhaustion, all the Alaska coal beds, no matter how remote or difficult of access, will have value, unless by that time some other source of energy finds utilization. This wide-reaching problem of economics has, however, but little bearing on the present monetary value of the coal lands. The term value as here used is intended to mean the highest present purchase price on which there will be a reasonable certainty of obtaining returns by the profit realized from the sale of the product of mining.

Many factors must be taken into account to estimate the money value of a given body of coal. Perhaps the most important of these is geographic position. If a coal field can not be made accessible by railway or steamer under present commercial conditions it has only a future or speculative value. The time when this coal can be economically brought to market may be so far distant that no individual or corporation can afford to purchase the coal lands, and then the field can be said to have no monetary value, though it must be taken into account by the economist who is considering ultimate fuel resources. Such a coal field must be classed simply as an asset of mankind, valuable at some distant time in the future when the more accessible coal fields are exhausted. It is probably safe to say that only under very exceptional conditions would a corporation purchase coal lands that could not be developed in less than a century. For example, there are known to be very extensive coal fields in northern Alaska beyond the Arctic Circle. Though these fields include some high-grade coals, they can hardly be said to have any present monetary value.

The same principle applies to coal beds either too thin or lying too deep for commercial recovery under any demands that can be foreseen. In estimating the value of Alaska coal land the average engineer will probably disregard any coal bed less than 2 feet in thickness, and also heavily discount any bed more than 2,000 feet in depth. Such coal beds, though they will eventually be mined, have no present monetary value, and yet must be included in estimating the tonnage of the ultimate coal reserves.

It is self-evident that the quality of the coal is an important factor in the valuation. It often costs as much to mine a lignite as a

bituminous coal, and yet the end product may be worth only two-thirds or half as much. On the other hand, if there is no competition with fuels of better grade, the lignites may sell at a price sufficiently high to assure a profit. As, however, much the larger part of the coal production of the world is consumed at or near tide water, high-grade fuels are usually transported at comparatively low cost. The improvements in gas-producer engines may eventually bring up the value of lignites by making them more available as a source of power. It is conceivable that such progress might even depress the value of bituminous coals by bringing them into competition with the more abundant lignites.

Under quality of coal must be considered not only composition and purity, which determine heat units, but also physical character. For example, there may be beds of high-grade coal in some of the Alaska fields that are so crushed as to be of little value at present. When, however, at some distant time in the future the demand for coal on the west coast has become greater than the uncrushed beds can be made to supply, even the crushed coal beds may be exploited for use under boilers or in making coke or briquets. Here again the crushed coal beds, though they may have no immediate money value, form a part of the ultimate fuel resources.

Cost of mining is of course one of the important elements in the valuation of a coal bed. Geographic isolation will increase costs in the early years of the development of a field because of the high price of labor, supplies, etc., but with the larger operations these costs are in time usually reduced. A far more important element in the cost of mining the coal is inherent in the character of the deposit. Complex folding very materially increases the cost of mining. Thickness of beds is also important, for the cheapest mining is done within certain limits, above and below which the cost is increased. The character of roof and floor may also have an appreciable influence on operating costs. Among many other factors the presence or absence of gas is important, as is also the position of the coal relative to the surface and the presence of ground water, for the hoisting of coal and the pumping of water add materially to the cost of production.

The market for the coal is another important element in determining value. Coal lands for whose product there is an unlimited market—other conditions being equal—will have a higher value than those for which a market must be developed. If it will take ten years, say, to develop a market for the coal of a particular field, it is self-evident that this element will discount the present money value of the land.

Coal lands purchased at a certain price must, of course, carry the compound interest charges and taxes until such time as returns can be

had from the product of mining. In other words, an acre of coal land held undeveloped for any period will, at the end of that time, represent not only the amount originally invested, but also the interest charges on that investment.[a] This can be best illustrated by an example. Suppose that coal lands are purchased at $10 an acre[b] and held without development for one hundred years. Then, compounding the interest annually at 5 per cent, the lands at the end of the century will represent an investment of $2,634 an acre, plus any taxes that may have been paid, with the interest thereon.

On applying the above consideration to Alaska fields it is found that probably the coal representing over half the known tonnage value will not be available for use until some distant time in the future and therefore can not be said to have any present monetary value. This includes most of the coal of the Arctic slope and over half that in the interior region.

Of the rest, it can be said of the lignites that their value is not high. Those lying on the Pacific seaboard must come into direct competition with better grades of coal, except in a very local market. The lignites of the interior can be mined and transported only at high cost, and hence their value under present conditions is very low. It remains to consider the value of the high-grade coals of the Bering River and Matanuska fields. Private coal lands are ordinarily sold by the acre, and in the past often little consideration has been given to the quantity of coal they contain. In the best practice now, however, the quantity of coal is estimated before a valuation is placed on the land.[c] In other words, the coal is estimated at so much a ton in the ground. Those unfamiliar with coal mining find it hard to understand why the value of a ton of coal in the ground should be so very small a fraction of its market price to the consumer. They lose sight of the facts that the coal in the ground is the raw material which the miner by his labor manufactures and the railway company transports, and that, as a rule, before the coal reaches the consumer several different individuals or corporations must have made a profit out of it.

The writer[d] has roughly estimated the accessible coal of the Bering and Matanuska fields as having a value of half a cent a ton in the ground. Exception has been taken to this valuation, but chiefly on the part of those who have given little consideration to the matter and who think of the value of coal in terms of its retail price to the consumer. To these persons a valuation of half a cent appears another way of expressing the thought that these lands have no value at all. This is, however, far from being the case, for half a cent

[a] It is assumed that there are no surface values to the land that can afford any returns.

[b] This is the present price fixed by law at which public coal lands in Alaska, more than 15 miles from a railway, are sold.

[c] Ashley, George H., The valuation of public coal lands: Bull. U. S. Geol. Survey, No. 424, 1910.

[d] Hearings before Joint Comm. to investigate Interior Dept. and Forest Service, 1910, p. 2845.

a ton is higher than the value of most of the eastern coal lands,[a] in spite of the fact that they are close to the centers of population and hence to markets. In fact, in some of the well-developed eastern fields good bituminous coal has recently sold for as low as one-thirteenth of a cent a ton in the ground.

If this ton value is transposed to a basis of so much per acre, it will admit more readily of comparisons. Few tonnage estimates have been made on the Bering River and Matanuska coal fields, but the best information available indicates that these lands will yield between 10,000 and 100,000 tons to the acre. This means that some of the lands will yield only 10,000 tons of coal to the acre; others may yield as much as 100,000 tons. Multiplying this acre tonnage by half a cent (the estimated value of the coal in the ground) indicates that these lands are worth from $50 to $500 an acre. Such values are far above the average of the bituminous-coal lands in the United States. Although the lands containing the coking coals of Pennsylvania have sold for $800 to $2,000 an acre,[b] in the other Appalachian fields the average values are $10 to $386, in the central fields $10 to $200, and in the Rocky Mountain fields $10 to $500.[c] It is evident, therefore, that the valuation of half a cent a ton for coal in the ground, far from being too low, is higher than the average in the States, and it is at least an open question whether purchasers at this rate could be found.

MARKET.

INTRODUCTION.

The possible markets for Alaska coal are, first, within the Territory itself, where, except for Seward Peninsula,[d] it can effectually shut out the imported fuels; second, in the Pacific States and Territories. It is improbable that, under the estimated cost of mining (see pp. 69–76), the Alaska coal can compete in foreign markets.

The present Alaska market can not support the large coal-mining industry which will be necessary to assure economic operations. Consequently Alaska coal will have to invade fields already supplied from other sources and come into direct competition with that which is mined in more accessible and more favored regions. It therefore becomes pertinent to this argument to inquire into the coal trade and, so far as possible, to present figures of consumption and prices.

The west coast is now chiefly supplied from the Washington and British Columbia fields. The fields of California, Oregon, and the

[a] Compare Bull. U. S. Geol. Survey No. 424.

[b] See Bull. 424.

[c] The prices quoted are based on actual sales of private lands.

[d] This refers to the bituminous coals of the Pacific slope, for experience has shown that the lignitic coals of the northeastern part of Seward Peninsula can compete with the imported fuels.

Rocky Mountains also supply some coal, as do those of New South Wales, Australia. Anthracite is brought from Pennsylvania, and during the last few years the Pacific fleet has been supplied from the New River and Pocahontas fields of West Virginia. Belgian coal in the form of coke also finds its way to the Pacific coast, and in some years there has been a considerable importation of Japanese and British coals. It would appear at first sight, therefore, that the market is under strong competition, especially in view of the large consumption of fuel oils. As a matter of fact, the price of coal on the coast, except in some portions of the area in close proximity to the domestic fields, has always been very high. The reasons for these conditions are too complex to permit analysis here. It appears, however, that the Washington fields supply not much more than enough for the markets of the State, and that the foreign coals dominate the California market. An important change will take place when the eastern coals reach the Pacific through the Panama Canal.

The statistics of coal and coke production annually published by E. W. Parker[a] leave nothing to be desired. The annual importations of coal are stated in the reports of the Bureau of Statistics.[b] For the local consumption of coal, far less reliable data are available. Mr. Parker's reports, which also deal with the general conditions of the coal trade, give much information, which the writer has supplemented by data gathered from trade journals, consular reports, and publications of boards of trade and state mine inspectors. These are the bases for the figures of coal consumption presented in the tables to follow, which are believed to be sufficiently accurate for the purposes of this discussion.

The production of the California oil fields during the last decade has been the controlling factor in the coal trade of the Pacific seaboard. Coal consumption has increased somewhat, yet not in anything like the ratio of the petroleum consumption. It is roughly estimated that 80 per cent of the California oil is used as fuel in the Pacific coast States and Territories. On expressing this fuel oil in the equivalent amount of coal, it is found that in 1908 the fuel-oil consumption was equal to nearly 12,000,000 tons of coal, compared with a total coal consumption of only about 4,500,000 tons. If it were not for the oil, there would apparently be a market for three or four times as much coal as is now used, though it is of course true that cheap fuel oil has stimulated certain industries which might not have developed if dependent on coal.

[a] Annual volume, Mineral resources of the United States, published by U. S. Geol. Survey.
[b] Austin, O. P., Foreign commerce and navigation of the United States, annual volume.

The following table is an attempt to estimate the consumption of mineral fuels in the Pacific coast States and Territories. For convenience of comparison the oil and coke are expressed in their equivalent of coal.

Estimated consumption of mineral fuels in Pacific coast States and Territories, 1899 to 1908, expressed in short tons of coal.

Year.	Petroleum.[a]	Coke.[b]	Coal.				Total coal and coke.	Grand total.
			Domestic.	Imported.	Total.	Percentage of domestic coal.		
1899	704,000	109,528	2,620,690	954,784	3,575,474	73+	3,685,002	4,389,002
1900	1,153,000	137,675	2,983,480	1,107,336	4,090,816	73−	4,228,491	5,381,491
1901	2,343,000	116,886	3,052,585	1,260,056	4,312,641	71−	4,429,527	6,772,527
1902	3,729,000	195,379	3,130,990	1,233,762	4,364,752	72−	4,560,131	8,289,131
1903	6,501,000	209,651	3,744,225	925,960	4,670,185	80+	4,879,836	11,380,836
1904	5,929,000	185,275	3,642,839	1,011,582	4,654,421	78+	4,839,696	10,768,696
1905	9,580,000	218,852	3,356,600	806,329	4,162,929	81−	4,381,781	13,961,781
1906	8,826,293	426,664	3,617,653	809,979	4,427,632	82−	4,854,296	13,680,589
1907	10,610,000	196,020	4,237,638	1,129,533	5,367,171	79−	5,563,191	16,173,191
1908	11,961,000	197,122	3,645,612	923,533	4,569,145	80−	4,766,267	16,727,267
	61,336,293	1,993,052	34,032,312	10,162,854	44,195,166	77+	46,188,218	107,524,511

[a] Equivalent of estimated consumption of California petroleum used as fuel (3 barrels = 1 ton of coal).
[b] Equivalent of coke produced and imported.

During the ten years 1899 to 1908, according to the foregoing table, the ratios of mineral fuel consumption were as follows: Coal, 41.1 per cent; coke, 1.9 per cent; fuel oil, 57 per cent. Of the coal 77 per cent was from domestic sources, and of this the Washington fields supplied about 85 per cent. British Columbia supplied about 50 per cent of the foreign coal and Australia about 20 per cent.

COAL CONSUMPTION IN THE PACIFIC STATES AND TERRITORIES.

It is the purpose of this section to discuss the coal consumption in several of the States and Territories which are believed to offer possible markets for Alaska coal. The Hawaiian coal consumption is not stated separately, though included in the above totals, for, except that used by the navy, it amounts to little. The coal consumption of the Philippine Islands will also not be discussed, for the coal fields of the islands appear to be ample for local needs,[a] and even if these were insufficient, the comparatively close proximity of the coal fields of Japan, Australia, and China would probably prevent the Alaska coal from competing in this market.

[a] Smith, Warren D., The coal resources of the Philippine Islands: Econ. Geology, vol. 4, 1909, pp. 224–238.

Coal consumption of Alaska, by sources, 1899 to 1908, in short tons.

Year.	Imported from States, chiefly from Washington.		Produced in Alaska, chiefly subbituminous and lignite.	Total domestic.	Total foreign coal, chiefly bituminous from British Columbia.	Total coal consumed.	Percentage of domestic coal.
	Bituminous.	Anthracite.					
1899	a 10,000	.....	1,200	11,200	50,120	61,320	18.26
1900	15,048	.....	1,200	16,248	56,623	72,871	22.30
1901	a 24,000	.....	1,300	25,300	77,674	102,974	24.58
1902	a 40,000	.....	2,212	42,212	68,363	110,575	38.18
1903	64,625	1	1,447	66,073	60,605	126,678	52.16
1904	36,689	.....	1,694	38,383	76,815	115,198	33.32
1905	67,707	6	3,774	71,487	72,567	144,054	49.63
1906	68,960	533	5,541	75,034	47,590	122,624	61.19
1907	45,130	1,116	10,139	56,385	b 88,596	144,981	38.89
1908	23,402	491	3,107	27,000	c 72,831	99,831	27.05
	394,561	2,147	31,614	429,322	671,784	1,101,106	38.99

a Estimated. b Fiscal year ending June 30, 1907. c Fiscal year ending June 30, 1908.

Alaska coal consumption has fluctuated greatly, as shown in the above table. This has been due, in part, to the lack of settled conditions in the placer fields. The great number of small plants in operation on the elevated beaches near Nome accounts somewhat for the large coal consumption of certain years. Railway construction, the amount of which has varied, also increases the consumption of coal. On the other hand, the amount of coal used by the canneries and lode mines along the Pacific seaboard steadily increased until 1908, when the Treadwell group of mines substituted oil-burning for coal-burning engines.

In 1908 about 30,000 tons of coal was consumed on Seward Peninsula, amounting to about 30 per cent of the total. It is by no means certain that the coal of the Bering River and Matanuska fields could compete in the Seward Peninsula market with that from other sources. These fields would have little advantage in distance of transportation to the Nome market over those of the Washington and Vancouver Island fields. If, however, the demand for coal in Seward Peninsula should increase, it might be worth while to consider the possibilities of supplying it from the Alaska Peninsula, only 700 miles distant from Nome.

In addition to the coal, Alaska is also a large consumer of fuel oil, as is shown in the following table. This oil is shipped to all settled parts of the Territory, including the interior and Seward Peninsula. It is used by many small mining plants in Seward Peninsula, by the Yukon River steamers, and very extensively for launches and small vessels throughout the seaboard.

Shipments of petroleum to Alaska, 1902 to 1908.

Period.	Crude petroleum.		Naphthas.
Six months ending—	*Gallons.*	*Barrels.*	*Gallons.*
December, 1902	21,000	500	60,358
June, 1903	840,000	20,000	210,147
December, 1903	1,008,000	24,000	84,776
June, 1904	1,008,400	24,010	231,658
December, 1904	1,008,030	24,001	106,623
June, 1905	1,780,326	42,389	499,196
December, 1905	935,060	22,263	214,300
June, 1906	11,428,000	34,002	361,681
December, 1906	1,260,100	30,000	219,297
June, 1907	2,545,200	60,600	354,210
December, 1907	6,558,500	156,155	282,671
June, 1908	3,852,940	91,736	599,959

The coal consumption of the State of Washington has probably less bearing on the question of markets for Alaska coal, because in this State there would be very strong competition with the local fields. At the same time the Alaska coal is of so much higher grade than the average of that from Washington fields that for some purposes it would dominate the market, provided it could be sold at competitive prices, considering the relative fuel values. This is particularly true of the coal used for ocean vessels.

Estimated coal consumption of Washington and Oregon, by sources, 1899 to 1908, in short tons.

Year.	Domestic.		Foreign.		Total domestic.	Total foreign.	Grand total.	Percentage of domestic.
	Washington and Oregon fields.	Other domestic fields.	Imported at Pacific coast ports.	Estimated consumption of Canadian coal in eastern Washington.				
1899	1,390,474	2,000	19,477	21,000	1,392,474	40,477	1,432,951	97
1900	1,766,083	500	20,976	12,000	1,766,583	32,976	1,799,559	99
1901	1,896,245	200	16,744	16,000	1,896,445	32,744	1,929,189	98
1902	2,286,766	300	39,116	62,000	2,287,066	101,116	2,388,182	96
1903	2,747,272	300	41,010	39,000	2,747,572	80,010	2,827,582	97
1904	2,803,937	200	51,170	73,000	2,804,137	124,170	2,928,307	96
1905	2,640,755	200	33,433	69,000	2,640,955	102,433	2,743,388	96
1906	3,112,904	300	69,685	113,000	3,113,204	182,685	3,295,889	94
1907	3,569,774	300	99,245	109,000	3,570,074	208,245	3,778,319	94
1908	3,024,256	300	157,704	164,000	3,024,556	321,704	3,346,260	90
	25,238,466	4,600	548,560	678,000	25,243,066	1,226,560	26,469,626	95

The California market, although, as indicated in the following table, one of apparently strong competitive conditions, yet seems to afford one of the best outlets for Alaska coal. Possible competition with eastern coals in this market after the completion of the Panama Canal is discussed on pages 91–92.

Coal consumption of California, by sources, 1899 to 1908, in short tons.

Year.	California.	Oregon (estimated).	Washington.	Rocky Mountain States (estimated).	Eastern States.[a]	Total domestic.
1899	160,615	70,000	627,450	320,000	38,951	1,217,016
1900	171,708	43,000	668,642	280,000	17,319	1,180,669
1901	151,079	48,000	674,391	230,000	27,370	1,130,840
1902	84,984	38,000	374,595	280,000	24,133	801,712
1903	104,673	61,000	384,645	370,000	13,262	933,580
1904	78,888	71,000	321,376	300,000	29,055	800,319
1905	77,050	79,000	166,445	310,000	11,663	644,158
1906	25,290	42,000	110,670	340,000	11,455	529,415
1907	13,950	26,000	87,346	400,000	83,883	611,179
1908	18,755	24,000	29,426	350,000	171,875	594,056
	886,992	502,000	3,444,986	3,180,000	428,966	8,442,944

Year.	British Columbia.	Australia.	United Kingdom.	Japan.	Total foreign.	Total.	Percentage of domestic.
1899	623,133	139,333	93,263	8,458	864,187	2,081,203	58
1900	766,917	178,563	54,099	11,398	1,010,977	2,191,646	54
1901	710,330	175,959	52,270	7,852	946,411	2,077,251	54
1902	591,732	197,328	99,221	19,378	907,659	1,709,371	41
1903	289,890	276,186	65,075	15,350	646,501	1,580,081	59
1904	335,137	148,409	66,330	88,213	638,089	1,438,408	56
1905	348,515	85,031	65,087	54,810	553,443	1,197,601	54
1906	311,099	72,638	37,215	21,546	442,498	971,913	54
1907	205,956	387,740	18,582	83,405	695,683	1,306,862	47
1908	167,415	228,174	15,110	21,285	431,984	1,026,040	58
	4,350,124	1,889,361	566,252	331,695	7,137,432	15,580,376	54

[a] Chiefly blacksmith and anthracite coal, but including, since 1907, considerable coal used by the navy.

The consumption of coke forms a very important feature of the possible market for Alaska coal. As already indicated, both the Matanuska and Bering River fields include a considerable amount of good coking coals. It has also been shown that some of the beds are likely to yield a large percentage of slack, and if this can be marketed in the form of coke it will form an important element in economic mining. The following table indicates that the coke consumption in this region has fluctuated greatly, but on the whole has increased during the last decade. Vancouver Island supplies most of the imported coke, but some metallurgical processes requiring coke of a high grade utilize Belgian coke.

Consumption of coke in Pacific States and Territories, by sources, 1898 to 1908, in short tons.

Year.	Imported from British Columbia, United Kingdom, and Belgium.					Total coke imported.	Manufactured from Washington coal.	Total coke consumed on Pacific coast.
	California.	Oregon.	Washington.	Hawaii.	Alaska.			
1898	40,011	442	13	.....	.....	40,466	30,197	70,663
1899	53,075	1,006	1,176	.....	.....	55,257	33,372	88,629
1900	39,968	440	1,615	.....	.....	42,023	33,387	75,410
1901	36,596	290	6,209	56	15	43,166	49,197	92,363
1902	58,547	1,416	25,062	668	53	85,746	40,305	126,051
1903	78,337	1,749	9,324	204	22	89,636	45,623	135,259
1904	69,520	4,309	76	146	49	74,100	45,432	119,532
1905	81,624	5,484	277	672	1	88,058	53,137	141,195
1906	77,207	2,768	221	392	8,543	230,326	45,642	275,968
1907	66,933	2,772	972	446	3,314	74,437	52,028	126,465
1908	80,874	4,712	1,590	1,080	31	88,287	38,889	127,176
	682,692	25,388	46,535	3,664	12,028	911,502	467,209	1,378,711

The consumption of anthracite has been small, chiefly on account of its high price. This market, at least, there is little question that the Alaska field will control. Even after the Panama Canal is completed, it is not likely that Pennsylvania anthracite can compete with that from Alaska.

Anthracite consumption of Pacific coast States and Alaska, 1899 to 1908, in short tons.

Year.	California.		Washington and Oregon.		Alaska, domestic and foreign.	Total.
	Domestic (estimated).	Foreign.	Domestic (estimated).	Foreign.		
1899	9,368	.....	2,000	468	.....	11,836
1900	3,400	.....	500	.....	.....	3,900
1901	5,400	.....	200	.....	.....	5,600
1902	4,800	.....	.....	320	.....	5,120
1903	2,600	6,138	.....	543	22	9,303
1904	3,000	22,543	.....	6,170	.....	31,713
1905	.....	65,417	.....	6,944	17	72,378
1906	2,000	37,156	.....	3,532	340	43,028
1907	2,000	19,206	.....	6,647	1,144	28,997
1908	2,000	21,175	.....	6,717	491	30,383
	34,568	171,635	2,700	31,341	2,014	242,258

PRICE OF COAL ON PACIFIC COAST.

Except in a few districts, the price of coal in the Pacific seaboard States and Territories fluctuates so greatly that it is very difficult to make any general statements which will be of value. For a number of years, however, there has been an upward tendency in coal prices in nearly all parts of the province. In general, it is true that the coal consumer has paid exorbitant prices for fuel. This is especially true in California, where competition with fuel oil seems to have demoralized the coal trade and prevented stable conditions on which business could be built up.

The average price for run-of-mine coal at the pit's mouth during 1908 was $2.21 per short ton in Washington, $2.74 in Oregon, $2.93 in California, and $4.83 in Alaska.[a] These figures, of course, do not indicate the cost to the consumer. To arrive at the price paid by the consumer it would be necessary to add transportation charges and profit for handling the coal. Moreover, a large percentage of the coal consumed in California is obtained from foreign sources.

The Vancouver Island coal sells, delivered at tide water, at $3.50 to $4.50 a gross ton. Transportation charges are about 75 cents to Seattle, and greater to California points, in addition to which there are the unloading charges and the duty of 40 cents a ton. Recently quoted Seattle wholesale prices are as follows: House or lump coal, $5; nut coal, $3.75; screenings, $2.25 a long ton. In California coal retails at $6 to $18 a gross ton, depending on point of consumption and quality of coal. The high cost of fuel on the Pacific seaboard is strikingly illustrated when comparison is made between the prices quoted above and those of coals on the Atlantic coast. For example, during 1908 the average wholesale price of bituminous coal in New York City varied from about $2.20 to $2.60 a gross ton.[b] This was for coal of a much better grade than any sold on the west coast. At the same time the wholesale price for anthracite varied from about $1.50 to $5, according to its size.

Along the Pacific seaboard of Alaska the retail price of coal has varied from about $8 to $15 and at Nome from $18 to $25 a ton. Practically no coal is imported into the interior except a little used for blacksmithing purposes, on which the freight alone would be $75 a ton. To these prices for coal in Alaska must be added the local transportation charges, which may amount to more than the original cost of the coal.

The comparisons of prices are far from satisfactory, as in some cases only wholesale and in others only retail prices are available. Moreover, the quality of the coal is not always definitely stated. A better index to coal prices is afforded by those on bunker coal. The following table has been compiled from the reports of the Bureau of Statistics and gives the cost of coal f. o. b. at various ports.

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[a] Parker, E. W., Mineral Resources U. S. for 1908, pt. 2, U. S. Geol. Survey, 1909, pp. 95, 100, 156-186.
[b] Idem, pp. 67-72.

Quantities in gross tons and average prices per ton of bunker coal supplied to vessels at Pacific coast ports, 1905 to 1909.

	1905.		1906.		1907.		1908.		1909.	
	Quantity.	Average price.	Quantity.	Average price.	Quantity.	Average price.	Quantity.	Average price.	Quantity.	Average price.
Humboldt, Cal.	742	$8.00	790	$7.79	890	$7.80	690	$8.00	616	$8.00
Los Angeles, Cal.	186	9.86	.....	.....	261	13.02	.....	.....	.....	.....
San Diego, Cal.	3,511	7.25	4,976	7.25	5,059	6.90	5,939	8.59	8,090	7.50
San Francisco, Cal.	111,871	5.75	273,960	6.04	232,856	7.04	196,274	6.47	157,622	6.26
Oregon, Oreg.	.....	.....	.....	.....	.....	.....	.....	.....	120	8.75
Southern Oregon, Oreg.	17,664	2.03	8,577	2.14	11,804	3.00	14,188	8.12	13,066	2.76
Willamette, Oreg.	5,984	5.29	4,270	5.42	6,040	6.06	5,123	6.92	2,373	5.77
Puget Sound, Wash.	355,542	3.01	492,246	3.00	661,662	3.70	339,869	4.00	363,004	4.00
Alaska	14,830	10.88	14,166	11.33	17,719	12.15	16,127	11.67	13,401	11.62
Hawaii	.....	.....	.....	.....	.....	.....	5,115	7.80	5,755	7.85
	510,330	4.21	798,985	4.23	937,919	4.73	583,325	5.13	564,047	4.89

It is probably safe to use the above table as showing the average wholesale price of coal in the Pacific coast towns. This indicates that in 1909 the average price per ton at California ports was about $7.25, at Oregon ports $5.79, at Puget Sound ports about $4, at Alaska ports about $11.62, and in Hawaii $7.85. The average for the Pacific coast outside of Alaska and Hawaii was $5.68, or more than double the average price on the Atlantic seaboard.

Special grades of coal which come from the East command fancy prices—blacksmithing coal $11 to $12 and anthracite $15 to $20 a ton. In 1908 the average price of Washington coke at the ovens was $5.48.[a] The average value of the coke produced at the Vancouver Island ovens in the same year is placed at $6 a ton.[b] The following prices for coke in the Pacific coast States have been collected from various sources and are sufficiently accurate to serve as approximations: San Francisco, furnace coke $8 to $10, gas coke $7 to $8; Portland, Oreg., and Washington coke $7, Belgian coke[c] $10 to $11.

COMPETITION BETWEEN ALASKA COAL AND OTHER FUELS.

It has been shown (pp. 82–86) that the Pacific coast States and Territories now use annually about 4,500,000 tons of coal, besides some 200,000 tons consumed as coke; also that there has been no marked increase in coal consumption during the last five years, because the increased demand for fuel due to larger population, the depletion of the forests in some districts, and general industrial progress has been met by the petroleum output of the California field.

During the five years that the coal consumption has remained the same the use of fuel in this territory has increased about 70 per cent.

[a] Mineral Resources U. S. for 1908, pt. 2, U. S. Geol. Survey, 1909, p. 277.
[b] Rept. Minister of Mines, British Columbia, 1908, p. J11.
[c] Coke pays a duty of 20 per cent ad valorem.

Therefore, it is the production of fuel oil which will in large measure control the market for coal. Though the productive areas are constantly being extended, it is only a matter of time when some of the pools will show a decline in output. The history of the longer developed eastern fields makes it fair to assume that the California oil pools will not show anything like the same rate of increase in output during the next decade that they have in the last decade. If this proves to be the case, a much larger use of coal is to be expected. It is therefore reasonable to suppose that in the future California petroleum will be far less of a competitor with Alaska coal than it would be were this coal now on the market.

In this connection it should be noted that some petroleum has been found in Alaska,[a] and while there has been practically no production, it is not impossible that commercial pools may be found. Oil seepages occur on the west shore of Cook Inlet, on the east side of the Alaska Peninsula, and on Controller Bay, all close to tide water and hence offering possibilities of cheap development.

Coke undergoes little direct competition with fuel oil. While there has been no marked increase in coke consumption for a number of years, yet such an increase is soon to be expected. Copper smelting on the west coast, notably in Alaska, when the Copper River district has been rendered accessible by railway, will undoubtedly increase the demand for coke. More important, however, to the coal miners are the advances made in the iron industry. Iron smelting has only recently been begun on a large scale in this province, but the plant now established on Puget Sound is undoubtedly the forerunner of others to follow. The raw materials are available, for iron occurs in a number of districts, and Alaska can supply the coke. Moreover, the market for iron is growing rapidly. It is estimated that the Pacific coast even now uses annually more than a million tons of raw and manufactured iron, nearly all of which is brought from the East or imported. If this iron were smelted on the Pacific seaboard, it would afford a market for, say, 2,000,000 tons of coking coal.

The present consumption of anthracite in this province is almost insignificant, being but about 30,000 tons annually. (See p. 86.) If, however, Alaska anthracite can be delivered at Pacific ports at, say, $5 a ton (p. 76), making its price to the consumer less than he is now paying for low-grade bituminous coals, a considerable market should be developed. It will probably take some time, however, to accustom the people to the use of anthracite. The annual per capita consumption of anthracite in the Northeastern States aver-

[a] Martin, G. C., The petroleum fields of the Pacific coast of Alaska: Bull. U. S. Geol. Survey No. 250, 1905; Notes on the petroleum fields of Alaska: Bull. U. S. Geol. Survey No. 259, 1905, pp. 128-139; Geology and mineral resources of the Controller Bay region, Alaska: Bull. U. S. Geol. Survey No. 335, 1908, pp. 112-130.

ages about 2 tons. This is, of course, much larger than it will ever be on the west coast, because of the difference in climate. In Virginia, however, which has a mild climate and where wood is largely used for domestic fuel, the annual per capita anthracite consumption in 1899[a] was two-tenths of a ton. This will serve as a rough measure of the possible future anthracite market in the Pacific coast States.

The following tables, compiled chiefly by Mr. Martin,[b] indicate the composition of the coals with which Alaska fields may come into competition:

Average composition of coal from countries bordering the Pacific Ocean.

District and kind of coal.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
Crows Nest Pass, British Columbia, average of 10 analyses[c d]	1.09	21.07	70.54	7.29	0.37
Vancouver Island, British Columbia, Comox, average of 9 analyses[d e f]	1.18	28.41	62.91	7.49	1.54
Vancouver Island, British Columbia, Nanaimo, average of 6 analyses[d e g]	2.12	34.07	55.94	7.93	.64
Washington, Wilkeson, average of 7 analyses[h i j]	.92	27.15	61.82	10.11	1.42
Washington, Cokedale, average of 3 analyses[h j]	1.27	28.04	62.30	8.39	.34
Washington, Blue Canyon, average of 3 analyses[h i k]	1.62	32.63	60.47	5.28	.53
Washington, Carbonado, average of 15 analyses[i k]	1.67	33.11	56.74	8.48	.94
Washington, Roslyn, average of 9 analyses[d h i j k]	2.68	34.37	52.75	9.87	.24
Washington, Franklin, average of 5 analyses[h i]	3.22	35.40	53.82	7.55	.15
Washington, Renton, average of 10 analyses[i j]	4.48	36.01	51.17	8.23	.61
Washington, Newcastle, average of 5 analyses[h i]	7.51	37.69	48.94	5.86	.48
Washington, Black Diamond, average of 4 analyses[h j]	4.44	40.50	51.73	3.33	.44
Oregon, Coos Bay, average of 4 analyses[h]	10.41	46.15	36.85	6.59	1.02
California, average of 10 analyses[l]	11.32	45.09	35.91	7.68	.....
Colorado-New Mexico, Durango-Gallup field, average of 2 analyses[m]	10.48	41.10	42.94	4.67	.....
Japan, average of 8 analyses[n]	2.62	42.49	50.07	4.82	.92
Philippines (Cebu), average of 9 analyses[o]	14.00	31.08	50.53	4.85	.....
Philippines (Batan), average of 5 analyses[o]	13.57	36.91	44.92	4.60	.....
New South Wales, southern, average of 21 analyses[p]	.97	23.10	56.26	10.67	.46
New South Wales, western, average of 13 analyses[p]	1.87	31.49	52.61	14.03	.63
New South Wales, northern, average of 77 analyses[p]	1.92	35.09	54.08	8.91	.54
New Zealand, bituminous coal, average of 23 analyses[q]	3.18	40.84	53.13	2.85	2.87

[a] Stoek, H. H., The Pennsylvania anthracite coal field: Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, p. 103.
[b] Martin, G. C., Geology and mineral resources of the Controller Bay region, Alaska: Bull. U. S. Geol. Survey No. 335, 1908, p. 111.
[c] Ann. Rept. Geol. Survey Canada, vol. 3, pt. 2, 1887-88, pp. 12T-15T.
[d] Ann. Rept. Minister of Mines, British Columbia, for 1902, p. 262H.
[e] Ann. Rept. Geol. Survey Canada, 1872-73, pp. 76-78.
[f] Ann. Rept. Geol. Survey Canada, 1876-77, p. 468.
[g] Ann. Rept. Geol. Survey Canada, 1882-1884, p. 37M.
[h] Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 3, 1902, pp. 490, 501, 510.
[i] Ann. Rept. Washington Geol. Survey, vol. 2, 1902, p. 270.
[j] Rept. State Inspector of Mines, Washington, 1901-2.
[k] Ann. Rept. Washington Geol. Survey, vol. 1, 1901, Pls. XXV, XXVII.
[l] Geology of California, vol. 3, p. 48.
[m] The Durango-Gallup field: Bull. U. S. Geol. Survey No. 316, 1907, pp. 421-423.
[n] Outlines of the geology of Japan, Imperial Geol. Survey, Japan, 1902, p. 190.
[o] The coal measures of the Philippines: Report to the United States military governor in the Philippines, War Department, 1901, pp. 178-181, 256-259.
[p] Mineral resources of New South Wales, 1901, pp. 324-348.
[q] Report on analyses of New Zealand coals, Mines Dept. New Zealand, 1907, pp. 6-7.

Average composition of some eastern coals.

District and kind of coal.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Remarks.
Pennsylvania, anthracite, average of 9 analyses [a].	3.39	3.81	83.79	8.42	0.59	Domestic coal.
Loyalsock, Pa., semianthracite, average of 4 analyses. [a]	1.49	11.07	78.88	7.69	.86	Do.
Pocahontas, W. Va., semibituminous, average of 38 analyses. [b]	.73	17.43	77.71	4.63	.62	Steam and coking coal.
Georges Creek, Md., semibituminous, average of 53 analyses. [c]	.70	18.81	72.96	7.26	1.01	Steam coal.
Connellsville, Pa., bituminous, average of 3 analyses. [d]	1.07	32.70	60.28	5.95	.81	Coking coal.
Fairmont, W. Va., bituminous, average of 63 analyses. [e]	.75	38.16	54.63	6.45	2.30	Coking [f] and steam coal.

[a] Ann. Rept. Geol. Survey Pennsylvania, 1885, pp. 313, 318.
[b] Rept. Geol. Survey West Virginia, vol. 2, 1903, pp. 695, 696, 700.
[c] Rept. Maryland Geol. Survey, vol. 5, 1906, pp. 631-633.
[d] Rept. Geol. Survey Pennsylvania, vol. MM, 1879, pp. 21-22.
[e] Rept. Geol. Survey West Virginia, vol. 2, 1903, p. 209.
[f] The phosphorus in these analyses ranges from 0.0019 to 0.037, averaging 0.0117.

The California coal so far produced has been entirely lignitic, but there are some bituminous coals in the State which will some time supply, in part at least, the local market. The extent of these fields is not such as to lead to the belief that they will afford serious competition with the Alaska coal. Oregon also has no very extensive coal fields, nor is the coal of a high grade.

The coals located east of the Cascades in the State of Washington are at some disadvantage in the coast market compared with those from Alaska, both because of their inferior quality and because of the long railway haul. There are some higher-grade coals in the western part of the State which are close to tide water. These, though they may dominate in the Seattle market, are not abundant enough to warrant the belief that they will be able to furnish any considerable part of the increased demand for fuel on the west coast. Therefore, while the Washington coal may be a serious competitor with Alaska coal in the present market, it is at least an open question whether this competition will be more than local in the future.

It is estimated that California annually consumes 300,000 to 400,000 tons (see table, p. 85) of coal from the Rocky Mountain fields. This comes chiefly from New Mexico and seems to be largely used for domestic fuel. It appears that, because of the long railway haul and the comparatively inferior quality of this coal, it is not likely to stand competition with the Alaska coal in the coast towns of California.

Probably a more serious matter to the future market for the Alaska coal is the possible competition with the fuels of the Appalachian fields after the completion of the Panama Canal. Unlike the other coals likely to reach the Pacific market, the Appalachian fuel is of the same high quality as that of the Bering River and Matanuska fields.

High-grade bituminous coal is now being delivered on shipboard at Atlantic coast ports at a cost of $2 a long ton. Emory R. Johnson [a] has estimated the cost of shipping coal from the Atlantic to the Pacific seaboard by way of the Panama Canal to be $2.45 a ton, including canal tollage. This would indicate that eastern coal might be delivered at San Francisco at about $4.60 a ton,[b] while it has been estimated (p. 76) that Alaska coal could be delivered at the same port for $4.50. As the error in the estimates is probably greater than the difference between the two figures, it seems as if there might be strong competition in this market between the Appalachian and the Alaskan coals.

Of the foreign competing fields those of Vancouver Island are nearest and have a higher-grade coal (see p. 90) than any others. They are, moreover, close to tide water, and the cost of mining should be less than in the Alaska fields. It appears from the best information available that the Vancouver Island collieries have been making a profit of $1 to $1.50 a ton, which is, of course, excessive. It is probable that under strong competition with Alaska fields the Vancouver Island operators may have to content themselves with a much smaller profit and be forced to introduce economies in mining and transportation. It is conceivable that under such conditions the Comox and Nanaimo coals might be delivered at Pacific ports at $3.50 a ton.[c] By allowing for the difference in fuel value, this would be the equivalent of $4.50 for Alaska coal. The local demand for the Vancouver Island coal will, however, be much greater when the Grand Trunk Pacific Railway is completed, and it may be that this domestic market will absorb the entire product of these collieries.

The New South Wales coal fields of Australia will probably continue to be competitors in the west-coast market, as they are to-day. (See table, p. 69.) Some of these fields lie close to tide water, and it has been estimated that their coal can be delivered on shipboard for $1.78 a ton.[d] With the cheap return freight rates offered by vessels

[a] Report on industrial and commercial value of canal: Rept. Isthmian Canal Comm., 1899–1901, 1902, Appendix NN, p. 349.

[b] This figure is obtained as follows:

Cost of coal delivered on shipboard, Atlantic port	$2.00
Ocean freights	2.00
Canal tollage	.45
Unloading charges	.15
	4.60

[c] This estimate is based on the following figures:

Mining cost	$1.90
Tramming to wharf and loading	.10
Duty	.40
Unloading charges	.15
Ocean freight	.70
Profit to coal-mine operators	.25
	3.50

[d] Daily Cons. and Trade Repts., No. 3373, January 6, 1909.

carrying wheat to Australia, the New South Wales coal may be able to compete with Alaska coals in the California market. If we assume, however, that Alaska coal can be delivered in California ports at $4.50 a ton, the Australian coals, which are of inferior quality, would have to be delivered at about $3.30 a ton.

New Zealand also includes some bituminous fields whose fuels are of about the same grade (see p. 90) as those of New South Wales. Though there are extensive deposits of lignite [a] in New Zealand, the bituminous coals [b] do not appear to be in sufficient quantity to justify the opinion that they will ever be an important element in the west-coast market.

Of the other countries bordering on the Pacific, China has the most extensive coal reserves.[c] The best Chinese coals as well as the most extensive fields lie inland. There is little probability that coals from China will be transported across the Pacific and come into competition with the Alaska fuels. The coal reserves of Japan [d] are not important either as to quantity or quality and little or no competition is to be expected from this source. The west coast of South America, too, has no great coal supply.[e] So far as known there are no important coal deposits in Central America or near the west coast of Mexico. In considering the coal market the possibilities of finding petroleum in these countries should be kept in mind. Peru, Chile, and other South American countries now annually consume several million tons of imported coal valued at $7 to $10 a ton, which is brought chiefly from Great Britain,[f] with some from Australia and a little from the Appalachian fields of the eastern United States. At first sight the South American countries would seem to furnish a promising market for Alaska coal. This coal, however, because of the distances of transportation, will have little or no advantage as compared with those of other fields, even if the first cost of mining were the same. For example, the distance from the Alaska fields to Valparaiso is about 7,000 nautical miles, compared with a distance of about 8,600 nautical miles from the English and 6,200 miles from the Australian fields. Moreover, on the completion of the Panama Canal, coal can be shipped from the Atlantic ports to Valparaiso by a water route only about 4,400 miles in length. It is not likely that under such conditions the Alaska coal could compete with that from the Appalachian fields.

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[a] Hall, Edward, The coal fields of Great Britain. London, 1905, pp. 348-352.

[b] There is also some anthracite.

[c] Willis, Bailey, Mineral resources of China: Econ. Geology, vol. 3, 1908, pp. 1-36, 118-133.

[d] Outline of the geology of Japan, Imperial Geol. Survey of Japan, Tokyo, 1902, pp. 188-208.

[e] Brough, Bennett H., Coal resources of the world: Final Rept. Royal Comm. on Coal Supply, pt. 11, appendix 6, London, 1905. Borlkjof, Z. C., The coal deposits of Peru: Eng. and Min. Jour., December 25, 1909.

[f] Daily Cons. and Trade Repts., No. 3617, November 23, 1909.

PRESENT MARKET FOR ALASKA COAL.

The above review of the Pacific coal markets indicates that the outlook for the Alaska coal is very favorable. However, the prospective Alaska coal producer is more vitally interested in the immediate market that he can count on. This is, of course, difficult to forecast, and in any event depends largely on the price at which Alaska coal can be mined and delivered. (See p. 76.) There is, however, a comparatively small local market which, because of its geographic position, the Alaskan coals will practically control. There is another part of the coal used in the Pacific market for which the Alaska coal will have a decided advantage over competing fuels. This includes that used by the navy, the blacksmithing coal and anthracite, a large part of the coal used for making coke, and some of that used by shipping. Then there is the larger market, chiefly in California, in which the Alaska coals will be under about equal competitive conditions with those from other regions. The following table sets forth an estimate of the tonnage required for these various uses:

Present estimated market for Alaska coal

	Tons.
Without competition.	
Local railways	50,000
Local towns	20,000
Local mines	10,000
Local smelters	10,000
Local and southbound steamers	30,000
	120,000
Under competition strongly favoring Alaska coal.	
United States Navy	150,000
Blacksmith coal	25,000
Anthracite	50,000
Coking coal (estimated at one-half of that now used)	100,000
Northbound steamers to Alaska Pacific ports	25,000
	350,000
Under competitive conditions about even.	
Seward Peninsula, Alaska	25,000
Coking coal (one-half that now used)	100,000
Steamers to Bering Sea	25,000
Trans-Pacific steamers	250,000
California ports	600,000
	1,000,000

The first section of this table needs no explanation except to state that the estimates are believed to be conservative. It has been assumed in the second section that the consumption of coal by the Pacific fleet will continue at about the same that it has in the last few years; also that, if the Alaska anthracite were mined near the market,

at least twice the quantity now used could be sold. It is also assumed that at least half the coking coal now used would come from Alaska. The remainder of the present consumption of coking coal has been put in the third section of the table, in which it was also assumed that the Alaska coal, because of its high grade, would become a competitor for the shipping trade. Finally, it is assumed that Alaska fields would compete for one-half of the coal used at present in California. It is fair to assume that the Alaska fuels would find market for at least half the quantity indicated in this section of the table.

These estimates, though they are little more than guesses, will perhaps show to what degree of magnitude the true figures belong. They indicate that at present there is market for some half a million tons, with little competition, and that there is another market for, say, a million tons more, in which the Alaska coal will have at least equal chances with that from other fields. In other words, there appears to be a present market for about 1,000,000 tons of the better qualities of Alaska coal. The total of the table represents less than a third of the total coal consumption on the Pacific coast. The data which have been presented in earlier sections of this paper will guide those interested in drawing their own conclusions as to how rapidly the market for Alaska coal is likely to grow.

BIBLIOGRAPHY.

The following list of publications is believed to include all those by members of the United States Geological Survey in which references of any importance are made to Alaska coal. It includes official publications as well as those printed privately. Only those marked with an asterisk (*) deal principally with coal; the others contain only minor references to production and occurrence of coal or descriptions of coal-bearing formations. The arrangement is, first, geographic, and within each group chronologic. Survey publications marked with a dagger (†) are out of stock but may be consulted at the larger public libraries.

During the last few years periodical literature has contained many references to Alaska coal. The more important of these are noted in a supplementary list, which is not intended to be complete. It comprises only such publications by others than members of the Survey as are believed may be of special value to those who are interested in Alaska coal. For the sake of historic interest a few older publications are, however, included in this list.

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General.

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Coal, by Charles A. Ashburner: Mineral Resources U. S. for 1885, U. S. Geol. Survey, 1886, p. 14.†

Coal, by Charles A. Ashburner: Mineral Resources U. S. for 1888, U. S. Geol. Survey, 1890, pp. 214-216.†

The Neocene of North America, by W. H. Dall and G. D. Harris: Bull. U. S. Geol. Survey No. 84, 1892, pp. 232-268.†

Coal, by E. W. Parker: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1893, pp. 209-210.†

*Report on coal and lignite of Alaska, by W. H. Dall: Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, pp. 763-906.†

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Alaska and its mineral resources, by S. F. Emmons: Nat. Geog. Mag., vol. 9, 1898, pp. 170-172.

Map of Alaska showing known gold-bearing rocks, with descriptive text, containing sketches of the geography, geology, and gold deposits and routes to the gold fields, by S. F. Emmons; a special publication of the U. S. Geol. Survey, 1898, pp. 39-44.†

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