

REPORT ON PROGRESS OF INVESTIGATIONS OF MINERAL RESOURCES OF ALASKA IN 1906.

By ALFRED H. BROOKS AND OTHERS.

ADMINISTRATIVE REPORT.

By ALFRED H. BROOKS.

PREFACE.

This volume, like those previously issued,^a will (1) summarize the results of the field work in Alaska for the year and (2) present a concise statement of the advancement of the mining industry in the Territory. It affords a means of giving to the mining public the important results of investigations that are underway or completed, pending the appearance of the more elaborate reports, always slow of preparation as well as of publication. Many of the papers contained in this volume have been prepared before the completion of the study of the material collected, and hence the conclusions advanced may not be accepted with the same authority as those contained in the detailed reports to be issued later. Nevertheless, it is believed that these preliminary statements are of value to the prospector and miner, even if they should be regarded only as suggestions.

As in former volumes, the papers here presented fall into three groups—(1) summaries of progress in various phases of the mining industry during the year, (2) preliminary accounts of investigations in progress or completed, and (3) statements of the results of minor investigations not to be published elsewhere.

The attempt is here made to cover the entire field of Alaska mining interests; but to do this it has been necessary to use, in part, information compiled from various sources. It is obviously impossible for the twelve geologists attached to the Alaska division to visit annually all the mining districts in the Territory and at the same time to carry on the more important work of studying the conditions of occurrence and

^a Report on progress of investigations of mineral resources of Alaska in 1904: Bull. U. S. Geol. Survey No. 259, 1905; idem, 1905: Bull. U. S. Geol. Survey No. 284, 1906.

distribution of the mineral deposits. It has been possible, however, to collect through correspondence considerable information in regard to the status of mining in the districts that were not visited by members of the Survey. The writer would here make acknowledgment to the many Federal officials, mine operators, and prospectors who have cooperated in the collection of these data.

The statistics presented on later pages show that the value of the mineral production in Alaska still comes very largely from the placers. Therefore the description of placer districts—the most important source of the mineral wealth—predominates in this report as in previous volumes. Again, as in previous years, a large part of the investigations and surveys were directed to the mapping of the placer districts of the Yukon and Seward Peninsula, which are the largest producers.

The composite authorship of this volume is evident from the fact that fifteen different papers are presented by eleven different authors. The arrangement of the contributions is, in general, geographic—from south to north. It is unfortunate that the exigencies of prompt publication make it imperative to omit all elaborate illustrations, the reproduction of which necessarily consumes considerable time, and to include only such outline maps and diagrams as can be quickly prepared for printing.

PROGRESS OF SURVEYS.

INTRODUCTION.

In 1906 fourteen parties were engaged in field work during a period varying from two and a half to six months. The technical force of these parties included twelve geologists, four geologic assistants, four topographers, and two hydrographers, in addition to which about thirty camp men were employed. Eight of these parties carried on geologic investigations, two made topographic surveys, three combined both classes of work, and one was employed in stream measurements and hydrographic reconnaissance. The aggregate of the areas covered by geologic reconnaissance surveys during 1906 is 9,000 square miles; by detailed geologic surveys, 548 square miles. Topographic reconnaissance surveys were carried over an area of 10,768 square miles; detailed topographic surveys, over an area of 40 square miles. Detailed hydrographic surveys were made over an area of 200 square miles and reconnaissance surveys over an area of 1,000 square miles. In addition to this, of the 28 Alaskan mining districts in which work is going on, 16, including all but one of the large producers, were visited by members of the Survey. The table on the next page presents a summary of the progress of surveys since the organization of systematic work in 1898.

Progress of surveys in Alaska, 1898-1906.

Year.	Appropriation.	Areas covered (square miles).					
		Recon- nais- sance geologic.	De- tailed geologic.	Recon- nais- sance topo- graphic.	De- tailed topo- graphic.	Recon- nais- sance hydro- graphic.	De- tailed hydro- graphic.
1898.....	\$46,189.60	9,500		14,912			
1899.....	25,000.00	6,000		8,688			
1900.....	25,000.00	10,000		11,152			
1901.....	35,000.00	12,000		15,664			
1902.....	60,000.00	17,000		20,304	336		
1903.....	60,000.00	13,000	336	15,008			
1904.....	60,000.00	6,000		6,480	480		
1905.....	80,000.00	8,000	550	8,176	948		
1906.....	80,000.00	9,000	414	10,768	40	1,000	200
	471,189.60	90,500	1,300	111,152	1,804	1,000	200

Although the actual areal surveys are tersely summarized in the above table many of the results can not be presented in this form. For example, practically every mining camp in Alaska has been investigated—some of them in great detail—yet the areal results of this class of surveys are very meager. This will account for the fact that with increased appropriations there has not always been an increase in the areas surveyed. Then, too, in the last three years much of the funds has been spent in detailed surveys, which, to speak roughly, cost ten times as much as the reconnaissance work.

The above table shows that nearly 500,000 ^a square miles in Alaska have not been covered by geologic reconnaissance surveys. Until this work is much more nearly completed all generalizations on the distribution of the mineral wealth must remain largely hypothetical.

Preliminary topographic surveys, including about 50,000 square miles covered by other Government bureaus, have been carried over less than a quarter of the entire area of Alaska. The importance of the rapid extension of such surveys can not be too strongly emphasized, for they furnish not only a guide to the prospector, but are absolutely essential to all engineering enterprises.

It is worthy of note that although nearly half a million dollars has been spent on Alaskan surveys and investigations this is only about one-half of 1 per cent of the value of the gold output from the Territory during the same period.

GEOGRAPHIC DISTRIBUTION OF INVESTIGATIONS.

GENERAL.

As in previous years, much of the time of the geologist in charge was given to administrative duties. The general supervision of the topographic work continued in charge of Mr. Gardine. During the writer's absence in the field Frank L. Hess looked after the office affairs of the division.

^a The area of Alaska is 586,400 square miles.

In June, 1906, the writer joined Mr. Kindle at Eagle and together they made a careful study of the geology along the upper Yukon. The main purpose of this work was to gather data which would serve to elucidate the stratigraphic problems, but incidentally some facts were obtained bearing on the occurrence of placer gold and of coal. From Circle the writer went overland to Fairbanks, making an examination on the way of the Birch Creek placer district. A few days were then spent in the Fairbanks district. At the invitation of Maj. W. P. Richardson, the writer joined the party of J. L. McPherson, engineer of the Alaska road commission, and carried a geologic reconnaissance westward from Fairbanks to the rapids on the Yukon, including a brief visit to the Rampart district. The month of September was spent in Seward Peninsula, with the Moffit and Hoyt parties, and in making a study of the Kougarok placer district.

After returning to the office the writer was occupied in preparing a statistical report on the gold and silver production of Alaska in 1905, which has been published in the Mineral Resources of the United States, 1905.

To W. W. Atwood was assigned the task of studying the stratigraphy of the Cretaceous and Tertiary coal-bearing rocks in the Territory, with the purpose of establishing correlation and obtaining information on the relative commercial value of the different fields. The details of this investigation are referred to in another place.

SOUTHEASTERN ALASKA.

The close of the last season witnessed the completion of the preliminary geologic mapping in southeastern Alaska as far northwest as Lituya Bay. There still remains, however, the survey of the Chilkat basin, the inland parts of the larger islands, and the more inaccessible portions of the high ranges. The work of last year embraced an area of about 3,000 or 4,000 square miles, extending northwestward from Lynn Canal to Lituya Bay and including a part of Chichagof Island. This survey was carried on by F. E. and C. W. Wright, assisted by R. W. Pumpelly. Though it was principally geologic some topographic reconnaissance surveys were made and much information was obtained on the retreat of the glaciers in the Glacier Bay region. At the close of the season C. W. Wright visited the Juneau and Ketchikan districts to collect data on the mining progress.

The urgent demand for detailed surveys of the more important mining districts in southeastern Alaska has been met so far as the funds available would permit. In 1906 R. B. Oliver made a survey, on a scale of a mile to the inch, of the more important parts of the Berners Bay district, embracing an area of about 40 square miles.

YAKUTAT-ALSEK REGION.

R. S. Tarr, assisted by B. S. Butler, continued his work in the Yakutat Bay region. He had hoped to cross the Malaspina Glacier to Cape Yaktag, but the fissuring which had taken place in this ice field since his previous visit in 1905 made it utterly impossible to carry out this plan. Mr. Tarr's observations in this region showed that since 1905 an advance of some of the glaciers had taken place. This is, of course, exceptional for Alaskan glaciers, but nevertheless may have an important bearing on the location of railway routes where the fronts of ice sheets have to be traversed.

Eliot Blackwelder, assisted by A. G. Maddren, made a geologic and topographic reconnaissance from Yakutat Bay southward to Alsek River. It was also planned to ascend that stream to the international boundary, but a serious accident prevented the accomplishment of this purpose. A statement of Mr. Blackwelder's results appears on pages 82-88 of this report.

CONTROLLER BAY REGION.

G. C. Martin completed the mapping of the accessible coal and oil fields of the Controller Bay district, begun in 1905. He was assisted by C. E. Weaver, and W. W. Atwood spent about a month in his party. Mr. Martin also carried topographic surveys over an area of about 200 square miles in this region.

COOK INLET REGION.

W. W. Atwood, assisted by C. E. Weaver, studied the stratigraphy of the lignitic coal-bearing rocks on both the east and west shores of Cook Inlet. This was part of the general plan to study the coal-bearing rocks of Alaska, already referred to.

A party under the direction of T. G. Gerdine made a topographic and geologic reconnaissance survey of an area of about 7,200 square miles lying northeast of and adjacent to Cook Inlet. Mr. Gerdine, accompanied by Adolph Knopf as geologist, mapped the valley of Knik River, portions of lower Matanuska River, and the area about its headwaters from Chickaloon Creek northward. R. H. Sargent, topographer, accompanied by Sidney Paige, geologist, mapped the area as far as practicable between Susitna and Matanuska rivers as far north as Chickaloon Creek and Talkeetna River, with an additional small area south of Knik River on the east side of Knik Arm.

At the end of the season Messrs. Gerdine and Sargent completed a traverse of the shore line from Knik southward to the mouth of Kasilof River, and Messrs. Paige and Knopf visited the Cook Inlet placer fields.

SEWARD PENINSULA.

F. H. Moffit, assisted by P. S. Smith, completed the areal mapping of the Nome and Grand Central quadrangles. This work is the first attempt to make an exhaustive study of the geology of any of the placer districts. It is hoped that as a result of such investigations general laws for the occurrence and distribution of the placer gold of the peninsula may be formulated. Mr. Moffit presents a brief abstract of his conclusions on pages 126-145 of this report.

Mr. Smith, in addition to his work with Mr. Moffit, made a reconnaissance of some of the other placer districts of the peninsula,^a both to gather data on the progress of mining and also to familiarize himself with some of the larger problems of the province.

Most placer mining is directly dependent on a supply of water; therefore a knowledge of the water supply is of first importance to this industry. The accurate determination of the mean discharge of any given stream must be based on observations extending through a long period of years to equalize the variations caused by abnormal seasons. Such an investigation was inaugurated at Nome during the last season. The area investigated embraced a belt of country about 20 miles wide, stretching inland from Nome to the Kigluaik Mountains, a distance of about 40 miles, and was chosen both because of its commercial importance and because the detailed maps were available for calculating the areas of stream basins. It is hoped that funds may be available to continue this work and to extend it to other parts of Alaska.

These hydrographic surveys were made possible only through the cooperation of the water resources branch, which detailed John C. Hoyt, an experienced engineer, to take charge. Mr. Hoyt spent about two months in the field, and the observations were continued by his assistant, F. F. Henshaw. A brief summary of results will be found on pages 182-186. The complete report has already been published.^b

YUKON DISTRICT.

L. M. Prindle, assisted by C. S. Blair, made a geologic reconnaissance southwest of the lower Tanana, covering about 2,000 square miles. The Kantishna placer district and a part of the Bonnifield, as well as the Cantwell coal field, were embraced within the scope of the investigation.

E. M. Kindle, assisted by V. H. Barnett, made a careful study of the stratigraphy of the Paleozoic rocks of the upper Yukon basin. In the course of this work he ascended Porcupine River as far as the international boundary. This investigation has an important bear-

^a See pp. 146-163.

^b Water supply of Nome region, Seward Peninsula, 1906: Water-Sup. and Irr. Paper No. 196, U. S. Geol. Survey.

ing on the correlation of the gold-bearing series of the Yukon-Tanana region.

Topographic reconnaissance surveys were carried westward from Fairbanks to the Yukon and southward to the Tanana by D. C. Witherspoon, assisted by R. B. Oliver. An area of 6,300 square miles was surveyed on a scale of 1:250,000. This completes the preliminary mapping of the Yukon-Tanana region west of the one hundred and forty-fourth meridian except for a narrow belt along the Tanana. In another season it is expected to complete the preliminary mapping of the area lying between Yukon and Tanana rivers and the one hundred and forty-second meridian.

PUBLICATIONS ISSUED IN 1906.

The following Alaska papers and maps were published by the Geological Survey during 1906:

REPORTS INCLUDING MAPS.

- BAKER, M., and McCORMICK, J. C., Geographic dictionary of Alaska, second edition: Bull. No. 299, 690 pp. (no maps).
- BROOKS, A. H., The geography and geology of Alaska; a summary of existing knowledge, with a section on climate by Cleveland Abbe, jr., and a topographic map and description thereof by R. U. Goode: Prof. Paper No. 45, 327 pp., 34 pls.
- BROOKS, A. H., and others, Report on progress of investigations of mineral resources of Alaska in 1905: Bull. No. 284, 169 pp., 14 pls.
- COLLIER, A. J., Geology and coal resources of Cape Lisburne region, Alaska: Bull. No. 278, 54 pp., 9 pls.
- MARTIN, G. C., Reconnaissance of the Matanuska coal field, Alaska: Bull. No. 289, 36 pp., 5 pls.
- MOFFIT, F. H., and STONE, R. W., Mineral resources of the Kenai Peninsula: Gold fields of the Turnagain Arm region (Moffit); Coal fields of the Kachemak Bay region (Stone): Bull. No. 277, 80 pp., 9 pls.
- PRINDLE, L. M., Description of the Circle quadrangle (one of a series on the Yukon-Tanana region): Bull. No. 295, 27 pp., 1 pl.
- PRINDLE, L. M., and HESS, F. L., The Rampart gold placer region, Alaska: Bull. No. 280, 54 pp., 7 pls.

MAPS PUBLISHED SEPARATELY.

- Casadepaga' quadrangle, scale 1:62,500.
- Grand Central special, scale 1:62,500.
- Nome special, scale 1:62,500.
- Solomon quadrangle, scale 1:62,500.

REPORTS IN PREPARATION, TO APPEAR IN 1907-8.

The following papers and maps are in various stages of preparation and will be published during 1907 and 1908:

REPORTS INCLUDING MAPS.

- BLACKWELDER, ELIOT, Geologic reconnaissance from Yakutat Bay to Alek River.
- BROOKS, A. H., and PRINDLE, L. M., An exploration in the Mount McKinley region (including a description of the Kantishna and Bonnifield districts).

- COLLIER, A. J., HESS, F. L., and BROOKS, A. H., The gold placers of a part of the Seward Peninsula.
- GRANT, U. S., The geology and mineral resources of Prince William Sound.
- HOYT, J. C., and HENSHAW, F. F., Water supply of Nome region, Seward Peninsula, 1906: Water-Sup. and Irr. Paper No. 196.
- MARTIN, G. C., Geology and mineral resources of Controller Bay region.
- MOFFIT, F. H., HESS, F. L., and SMITH, P. S., The geology and mineral resources of the Nome and Grand Central quadrangles.
- PAIGE, SIDNEY, and KNOPF, ADOLPH, Geologic reconnaissance in the Matanuska and Talkeetna basins.
- PRINDLE, L. M., Description of the Fairbanks and Rampart quadrangles (one of a series on the Yukon-Tanana region).
- SPENCER, A. C., The Juneau gold belt, Alaska; and WRIGHT, C. W., A reconnaissance of Admiralty Island: Bull. No. 287.
- TARR, R. S., Geologic reconnaissance in Yakutat Bay region.
- WRIGHT, C. W., and WRIGHT, F. E., Mineral resources of the Wrangell and Ketchikan districts.

MAPS TO BE PUBLISHED SEPARATELY.

- Berners Bay special, scale 1:62,500.
- Controller Bay region special, scale 1:62,500.
- Northwestern part of Seward Peninsula, scale 1:250,000.
- Northeastern part of Seward Peninsula, scale 1:250,000.
- Southern part of Seward Peninsula, scale 1:250,000.

THE MINING INDUSTRY IN 1906.

By ALFRED H. BROOKS.

FOREWORD.

An increase of nearly 50 per cent in the value of the gold output of 1906 over that of the previous year is the most concrete evidence of the advancement of the mining industry in Alaska. That copper mining, too, has undergone a rapid expansion is manifest by an increase of at least 20 per cent in production over the previous year. Other mineral deposits, such as coal, marble, tin, and gypsum, have also received considerable attention. This progress has consisted chiefly in the development of the older districts rather than in the discoveries of new mineral fields, and can, therefore, be interpreted as an index of continuous advancement rather than abnormal expansion.

Though the placer mines of Nome and Fairbanks were by far the greatest producers of wealth last year, yet they have probably received less attention from investors than the problems of railway construction along the Pacific slope of the Territory. This is another indication of the healthy expansion of the commercial interests and augurs well for a long period of prosperity.

The influx of capital seeking investment in Alaska, so notable during the last few years, continued during 1906. A large number of prominent engineers have been engaged examining prospects and mines, as well as conditions of operating, transportation, etc., in the interests of prospective investors. Unfortunately, with the many legitimate enterprises there is an equal if not greater number of ventures which are promoted with a view of exploiting people ignorant of mining affairs rather than of developing mines. The public can not be too strongly urged to familiarize themselves thoroughly with the plans and assets of companies that invite popular subscription. Many honest promoters, because of their inexperience in mining affairs, mislead their equally inexperienced stockholders. Every such venture which fails retards the advancement of the mining interests by making investors suspicious of all other enterprises in the district.

STATISTICS.

The collection of accurate statistics of mineral production, a task much beset with difficulties even in well-settled regions, is in Alaska, with its indifferent mail facilities, as yet well-nigh hopeless. Up to 1905 no systematic attempt was made by the Geological Survey to gather statistics at first hand, the work being limited to distributing among the different districts, according to the best information available, the totals as published by the Director of the Mint. The first attempt to gather this kind of information was confined to estimates furnished by residents of the Territory and in many cases checked by the personal observations of the geologists working in various fields. By 1906 the improvement of the mail facilities and general accessibility of the country was deemed to have gone far enough to warrant an attempt to obtain statistics through schedules sent to the individual producers. This experiment was, however, only partially successful. Though nearly all the lode miners throughout the Territory have been prompt to reply and to send the desired information, the returns received from placer miners were very disappointing. Most of the small operators in the less important districts have, indeed, shown their willingness to cooperate in this statistical work by furnishing the desired information, but on the other hand the majority of the large operators, especially in the Nome region, have either ignored the request for information entirely or have returned the schedule without furnishing any information as to production. This seems particularly unjust, because it is the large operators who have benefited most by the work of the Geological Survey, and it seems as if they should have shown their good will by acceding to the request for information. In undertaking this work the writer believed that the mine operators would be the first to recognize its importance and would, therefore, be willing to cooperate. It has been a source of deep disappointment to him that such has not proved to be the case. While it may appear at first thought that by replying to the questions asked on the circular an operator is revealing information which might be used to his disadvantage, yet this fear is groundless, because the schedules are used only to make up totals of districts and all individual productions are held in strict confidence. It is the earnest hope of the writer that in the future mine operators may further the collection of reliable statistics and show their confidence in the Geological Survey by furnishing the desired information. The following table of gold production is based on the best information available. The totals since 1898 are probably correct within 5 or 10 per cent, but the error in distribution of these totals among the various districts is probably much greater.

Value of gold production of Alaska, with approximate distribution, 1880-1906.

Year.	Pacific coastal belt.	Copper River and Cook Inlet region.	Yukon basin.	Seward Peninsula.	Total.
1880.....	\$20,000				\$20,000
1881.....	40,000				40,000
1882.....	150,000				150,000
1883.....	300,000		\$1,000		301,000
1884.....	200,000		1,000		201,000
1885.....	275,000		25,000		300,000
1886.....	416,000		30,000		446,000
1887.....	645,000		30,000		675,000
1888.....	815,000		35,000		850,000
1889.....	860,000		40,000		900,000
1890.....	712,000		50,000		762,000
1891.....	800,000		100,000		900,000
1892.....	970,000		110,000		1,080,000
1893.....	833,000		200,000		1,038,000
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	9,160,000
1905.....	3,430,000	500,000	6,900,000	4,800,000	15,630,000
1906 ^a	3,500,000	400,000	10,400,000	7,500,000	21,800,000
	37,465,400	3,135,000	25,481,000	37,262,700	103,348,700

^a Preliminary estimates.

The silver production of 1906 is estimated to have been about 170,000 ounces, compared with 132,000 ounces in 1905. In 1906 the copper production is estimated to have been somewhat over 7,600,000 pounds, compared with 4,800,000 pounds in 1905. The output of other mineral products will be discussed in succeeding pages.

Estimated value of Alaska's mineral production in 1906.

Gold.....	\$21,800,000
Silver.....	120,000
Copper.....	1,200,000
Coal.....	20,000
Miscellaneous, including tin, marble, etc.....	10,000
	<hr/>
	23,150,000

TRANSPORTATION.

Transportation problems are still in the forefront throughout Alaska. Steamboat service, both on the rivers and oceans, is being rapidly improved, but with the exception of a few short railways overland transportation is still very primitive.

In Seward Peninsula two railways, referred to elsewhere (pp. 144, 153), have been extended, giving a total length of about 100 miles. In the Yukon region the railway from Fairbanks to Pedro Creek is doing a noteworthy service to the mining interests, but needs to be extended. On the Gulf of Alaska two railways are being constructed, one from Resurrection Bay and one from Cordova Bay, and other projects are

being earnestly considered. The railway situation, as regards inland extensions, leaves much to be desired, as the various interests are in many cases antagonistic. Current reports indicate that two important projects for a railway to the copper fields of the Chitina and the Controller Bay coal field are to be merged, which will assure early connection with these important mineral districts. Year by year the demand for railway connection of the inland region with open water on the Pacific becomes more imperative. Until such lines of communication are established, the development, if any, attainable by the interior districts will be very slight.

The Alaskan road commission, under the direction of Maj. W. P. Richardson, is doing much to help the mining interests in various parts of the Territory by highway and trail construction. As there is no form of local government outside of incorporated towns, the miner is entirely dependent on the Federal Government for the advancement of road construction, and it is to be hoped that the road commission may have sufficient funds to meet the many worthy demands for highways.

DISTRIBUTION OF PRECIOUS METALS.

It is the ultimate purpose of the geologic investigations carried on in Alaska to determine the laws governing the occurrence and distribution of the precious metals. Such a determination, however, must await far more detailed and comprehensive studies than have yet been accomplished. Meanwhile, with the progress of this work, there is an accumulation of evidence which suggests certain conclusions not yet susceptible of proof. As these may serve as a guide to the prospector, it will be desirable to set them forth briefly.

It has long been demonstrated that ore bodies, as a rule, occur in rocks which have been subjected to more or less alteration, or metamorphism, as it is usually called. Such metamorphism may be regional—that is, it may have been brought about by stresses in the earth's crust which have affected large areas—or it may be due to local disturbances, many of which are caused by intrusive masses. It is also possible that both regional and local metamorphism have affected the same formation. It should be noted that where there is any considerable metamorphism, both chemical and physical changes usually take place, as for example in the alteration of shale to schist or of granite to schist. These rock changes are important to the miner because, by increasing permeability, etc., they affect the occurrence of ore bodies, and necessarily the derived placers.

On the accompanying map (Pl. I) the distribution of the metamorphic rocks is indicated so far as they are known. These areas indicated as metamorphic have thus far been the wealth producers, as

they contain over 99 per cent of all the gold mines in the Territory. It does not follow, however, that there are no precious metals outside of the metamorphic areas. For example, the Apollo mine on Unga Island, in southwestern Alaska, is in a series of comparatively recent lava flows which have been altered only very locally. Again, some of the Tertiary conglomerates in the Yukon basin are known to be auriferous, but it should be said that in this case the gold was undoubtedly derived from the metamorphic terranes. These exceptions to the general law are of importance because they show that other formations than those indicated as metamorphic may contain precious metals.

The map clearly shows that there are three general zones of metamorphic rocks in Alaska. One skirts the Pacific seaboard, stretches through southeastern Alaska, and appears to occur again on lower Copper River, on Kenai Peninsula, and on Kodiak Island. It is not to be inferred that this belt is made up entirely of formations of the same age, though such may prove to be the case. The map is intended simply to express the fact that in this belt there are considerable areas of metamorphic rocks. In southeastern Alaska these altered rocks belong to Paleozoic terranes, but to the west no definite age determination has been made.

A second and much larger belt of metamorphic rock lies to the north and west of the coastal zone, stretching from the international boundary through the Yukon and Tanana region, and appears to trend to the southwest, paralleling like the first the larger structural features of the Territory. This belt is broken near Yukon River by younger beds, but appears again in Seward Peninsula. A third belt, whose relation to the second has not been established, as the intervening areas are occupied by younger sediments, stretches through the upper Koyukuk Valley and is found again on the Kobuk. Though the map suggests that the easterly extension of this third zone should be found in the Porcupine Valley, yet the work of E. M. Kindle has shown that while the same rocks are probably present near the point where the international boundary crosses the Porcupine, they are there not altered. This emphasizes the well-known fact that although a group of terranes may be highly altered in one locality, its extension may be made up of slightly altered rocks. The prospector should bear this fact in mind in seeking for new mining fields. So far as the evidence goes, the Porcupine basin does not seem a promising field for gold discoveries. On the other hand, the metamorphic rocks of Seward Peninsula probably find an extension east of the locality where they are indicated on the map. The metamorphic rocks of the inland areas are probably chiefly of Paleozoic age. Between the two general zones of metamorphic terranes there are some smaller belts of

highly altered rocks which locally have proved to be gold bearing. It is presumable that some of these will be found to cover larger areas than here indicated.

The experienced prospector need not be told that it does not follow that because a certain formation is gold bearing gold will be found wherever it occurs. A tyro, however, may interpret the accompanying map as an absolute indication of the distribution of gold rather than as a guide to localities where the precious metal is likely to be found. Although the laws governing the distribution of gold in this field are but imperfectly understood, it seems certain that the occurrence of mineralization is due to causes that have in many places acted very locally. There appear to be no facts which bear out the assumption often made that there are one or more well-defined gold belts which can be traced across Alaska, though the formations with which gold is associated may be found to be continuous over extensive areas. The work so far accomplished appears to justify the statement that within the areas of metamorphic rocks there are zones of mineralization. These are, however, usually of very slight extent, ranging from only a few hundred yards to rarely a few miles in length. There is but little information on which to formulate a law for the occurrence of these mineral zones, and it is quite possible that in the different districts different causes have been operative.

It appears to have been definitely established by Mr. Wright (see pp. 49-50) that in southeastern Alaska there is a causal relation between the intrusion of the Mesozoic granites and the ore bodies. As he sets forth, the zones of mineralization thus far discovered all occur along or near the margins of the intrusive granite masses. There is some evidence that a similar association of the zones of mineralization and the granite exists in the Yukon district. Prindle has shown that granitic rocks are common in all the gold-placer districts of the Yukon-Tanana region and that in at least one locality the gold is closely associated with intrusive phenomena. He has also suggested that intrusion and the formation of quartz veins took place at different periods.^a During the last summer the writer found evidence of mineralization accompanied by deposition of gold in the so-called Aucella beds (lower Cretaceous) on Washington Creek, a tributary of the Yukon. This appears to be the first instance in this province where definite proof was obtained of a post-Paleozoic mineralization, and is significant because it appears to belong to the same period as the intrusion of auriferous veins in southeastern Alaska.

Mendenhall^b has shown that in the Chistochina placer district of upper Copper River the mineralization is post-Permian and pre-Eocene,

^a Prindle, L. M., The gold placers of the Fortymile, Birch Creek, and Fairbanks regions, Alaska: Bull. U. S. Geol. Survey No. 251, 1905, p. 37.

^b Mendenhall, W. C., Geology of the central Copper River region: Prof. Paper U. S. Geol. Survey No. 41, 1905, p. 115.

so that it may be correlated with that on Washington Creek. Moreover, his geologic map shows the gold-bearing area to be intruded by many igneous rocks which are of the same general composition as the granites of southeastern Alaska. In other words, this occurrence appears to be closely analogous to the gold deposits of southeastern Alaska. Furthermore, some evidence is at hand which suggests a similar origin for the gold of the Susitna basin.

It is safe, therefore, to assert that the intrusion of the Mesozoic granite in many parts of Alaska was accompanied or followed by the formation of auriferous veins. It is important, therefore, to draw attention to the distribution of this rock. As shown by Mr. Wright, it not only forms the major portion of the Coast Range, but also finds a wide distribution in isolated stocks among the islands to the west. The main granite mass passes into Canadian territory in the Chilkat basin and has been traced northward to Kluane Lake, where, too, evidence of mineralization is found. It occurs again in the form of dikes and stocks along the northern margin of the Copper River valley and has been recognized at a number of places in the Alaska Range to the southwest.

The genetic relation of the auriferous deposits of Seward Peninsula is still an unsolved problem, but so far no connection with the granitic intrusions has been established. Mr. Moffit shows elsewhere in this report (see pp. 130-132) that the placer gold of the Nome region proper finds its source in a series of closely folded and faulted metamorphic rocks and apparently most commonly along the contact between the schists and crystalline limestones. The only ore deposits in this province which have been found in association with granite intrusions are the cassiterite lodes, which, as Collier^a and Hess^b have shown, are closely connected with the intrusions. The developments of the past year at Cape Mountain clearly show that the tin ores occur along the margins of the granite. It is unfortunate that little is known of the age of this granite. While it has generally been regarded as Paleozoic, it may be Mesozoic, but is certainly pre-Eocene.

The matter already presented refers chiefly to the auriferous veins, but is probably applicable to some of the copper deposits, especially in southeastern Alaska. In Prince William Sound^c the copper deposits are intimately associated with greenstones and greenstone schists, probably of Mesozoic age, which are relatively little altered. Granite intrusions are present in this province, but the ore bodies are not known to have any genetic relation to them. The copper ores of Copper River occur as contact deposits along a semicrystalline lime-

^a Collier, A. J., Tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 229, 1904; Recent development of Alaskan tin deposits: Bull. U. S. Geol. Survey No. 259, 1905, pp. 120-127.

^b Hess, F. L., The York tin region: Bull. U. S. Geol. Survey No. 284, 1906, pp. 145-157.

^c Grant, U. S., Copper and other mineral resources of Prince William Sound: Bull. U. S. Geol. Survey No. 284, 1906, pp. 78-87.

stone and a greenstone which is probably an ancient lava flow.^a The foregoing statements indicate that some of the copper-bearing lodes of Alaska appear, in part, at least, to be the result of a different group of phenomena from those which caused the auriferous lodes.

LODE MINING.

INTRODUCTION.

The most notable advance in lode mining during 1906 was the development of the copper deposits of the Ketchikan district and of Prince William Sound. While steady progress has been made in the auriferous mines of the Juneau district there were no marked developments. Statistics are not yet available, but it is not probable that the output of gold from this district was notably greater than in 1905, nor have any important discoveries of new auriferous-lode districts been reported. In Seward Peninsula the one developed lode mine has continued to be a producer and there was a noteworthy activity in prospecting quartz veins, but here also no important discoveries have been reported. Statements are current that auriferous copper-bearing lodes have been found in the Kobuk Valley and in the Susitna basin, but the proof of their commercial value will have to await further investigations. The same holds true of the auriferous lodes reported from Kenai Peninsula and Kodiak and adjacent islands. The copper-bearing property in the Iliamna Lake region has received some attention, but the writer has scanty information regarding it. It is at least of interest in suggesting the occurrence of mineralization in this little-known field. Though auriferous veins have been found in the Yukon basin, nothing of commercial importance has so far been developed.

STATISTICS.

It is unfortunate that the statistical data are not all in hand yet and that therefore the production can be stated only in general terms. It is probable that the value of the gold production from siliceous ores for 1906 is about \$3,450,000 and that the copper ores yielded about \$100,000 in gold. The value of the silver from both classes of ore for 1906 is probably about \$50,000. The copper production of 1906 is estimated to have been about 6,000,000 pounds, valued at about \$1,100,000. It is estimated that thirteen gold and silver mines were on a productive basis in 1906, as compared with ten in 1905. Fourteen copper mines are believed to have been operated in 1906, as compared with eight in 1905. In addition to the productive mines many prospects were being developed, especially in the copper districts. It has been impossible to gather any complete data in regard to the

^a Mendenhall, W. C., and Schrader, F. C., Mineral resources of the Wrangell region: Prof. Paper U. S. Geol. Survey No. 15, 1903.

number of placer mines, but it is fair to presume that they include at least 1,200 different operations. In the absence of accurate information about tonnage and values for 1906 it seems worth while to make the following quotation in relation to the production of 1905:

The tonnage of all the lode mines of Alaska in 1905 was 1,422,515 short tons, an increase of probably about 40,000 tons over 1904. Of siliceous ores 1,370,316 tons were mined, of which 1,296,271 tons must be credited to the three mines of the Treadwell group on Douglas Island, near Juneau, leaving only 74,045 tons as the product of the other gold-quartz mines. The average gold and silver value of all siliceous ores was \$2.63 per ton. For the 74,045 tons of siliceous ores other than those from the Treadwell group it was \$5.60. A total of 52,199 tons of copper ores contained an average of \$1.66 per ton of gold and silver, and copper to the amount of 4.61 per cent. It should be stated that the values of the siliceous ores mined thus far lie almost altogether in the gold, the silver values being often less than 1 per cent of the total. The high percentage of copper is accounted for by the fact that the Prince William Sound mines, which contributed a large percentage of the total tonnage in 1905, have so far shipped only high-grade ores. The copper percentage of ores from the Prince William Sound mines is nearly twice that of ores from the mines of southeastern Alaska.^a

It can be added that the tonnage and values in the siliceous ore were probably about the same in 1906 as in 1905. The copper ores in 1906, however, showed an increase of at least 20 per cent, but the values remained about the same.

LODE DISTRICTS.

The southeastern Alaska districts are fully treated in other pages of this report. Prince William Sound and Copper River were not visited by any member of the Survey and the following notes are compiled from various sources.

The copper mines and prospects of Prince William Sound thus far discovered all fall within a zone about 10 to 20 miles in width stretching northeastward from Latouche Island to Boulder and Galena bays on the mainland. An examination of the map (Pl. I, p. 22) shows that much of this zone is under the water of the sound. As Grant^b has shown, the ore bodies, chiefly chalcopyrite, occur as a rule along shear zones in the greenstone.

Two mines, the Gladhaugh and Bonanza, made shipments of ore to the Tacoma smelter throughout the year, and several other properties undergoing development also made some production. In the Gladhaugh mine a sixth level at 600 feet depth is said to have been reached. Though only a few properties have reached a shipping stage, there are probably two score that have been prospected during the past year. Most of this work was done on Latouche and Knight islands and at Boulder, Landlocked, and Galena bays. It is estimated that from 100 to 200 men have been almost continuously

^a Brooks, Alfred H., Mineral resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 129.

^b Grant, U. S., Copper and other mineral resources of Prince William Sound: Bull. U. S. Geol. Survey, No. 284, 1906, pp. 78-87.

employed in these operations. It seems probable that in 1907 the number of productive mines will be very much increased.

The two copper belts on the north and south sides of the Wrangell Mountains continue to be a field of much prospecting. Developments have been confined chiefly to the more accessible southern belt, which it is expected will be connected by railway with tide water in the next two years. This mineral belt has been carefully traced by prospectors and probably most of it has been preempted by this time. On most of these claims, however, assessment work alone has been done. There has been systematic development on a number of larger holdings, notably on the Hubbard-Elliot property near the west end of the range, and on the Bonanza near the east end. It is claimed that a depth of 200 feet has been reached on the Bonanza.

In the upper copper belt, stretching more or less brokenly from White River to the head of Tanana and Copper rivers, a score or more prospectors have been at work and several new discoveries are reported. Some of them are so close to the international boundary that until an accurate delineation of that line is made it will be uncertain on which side of it they lie. It is reported that native copper-bearing lodes have been found on Kletsan Creek and on Camp Creek. The other copper deposits of this region are chiefly sulphides.

The most important fact in regard to the development of these copper districts is the assurance of a railway from the coast. Although the location of the coastal terminal, if current reports are to be credited, is not yet definitely settled, it probably will be either Cordova Bay or Katalla, from which a railway will be extended up Copper River. Meanwhile steps have been taken to establish means of communication by small steamers which will run between the rapids of Copper River and will be provisionally connected by tramways.

YORK TIN REGION.

No member of the Geological Survey visited the tin district during 1906. Current reports indicate considerable progress in lode mining at Cape Mountain and prospecting at Lost River and at Brooks and Ear mountains. The Buck Creek tin placers also received attention, and some shipments of stream tin were made.

The margin of the granite mass of Cape Mountain, which appears to be the locus of the tin-bearing lodes, has been traced and entirely covered by locations, and considerable prospecting has also been done. During the last year cassiterite-bearing veins were found on the northwest side of the mountain, in the basin of Village Creek. The prospects are reported to be encouraging and at least are known to have the same general character as the better developed deposits on the southeast side of the mountain. By far the most extensive

operations of the district are those of the Bartels Tin Mining Company, on the southern slope of Cape Mountain. This company installed a 3-stamp mill in 1905, and some concentrates were shipped during the year. Current reports, which the writer is unable to verify, indicate that the ledge varies in thickness from 18 inches to several feet. Values of 1 to 55 per cent are reported, and the average of the ore mined is said to have been $3\frac{7}{8}$ per cent. The company is mining and also prospecting systematically with electric-power drills. An enlargement of the plant is said to be in contemplation. The United States-Alaska Tin Mining Company has erected a 10-stamp mill in the same region, but no shipments are reported. The Seward Tin Mining Company is said to be at work in the same vicinity, and some prospecting is reported on the Compass, Bear, Midnight, and Sun claims. The developments on the north side of Cape Mountain, at Village Creek, have already been referred to.

Less definite information is available concerning the operations at Ear Mountain and Lost River, but current reports indicate that systematic prospecting is still going on. The Lost River deposits are near the coast, but the Ear Mountain district is less accessible.

As no further studies have been made, it is impossible to present any conclusions in regard to the future of the district beyond those already advanced by Collier^a and Hess.^b The actual shipment of ore and the continuation of work in the various localities bear testimony of progress. There can be no doubt that this district has suffered by the exaggerated estimates of the tonnage of ore developed and its value, which have been published far and wide. While these are in part to be credited to conscienceless promoters, who are using tin prospects as a basis for the selling of stock, it is also due to the ignorance of honest prospectors. Nearly all the owners of tin prospects hold them at such enormous figures that the experts sent to examine them often must advise their clients against purchase. Those who are inexperienced in lode mining, especially of tin ores, should understand that capitalists will not pay for a prospect the same amount of money which they would for a developed mine. Had this fact been accepted by the prospectors, much more prospecting would no doubt by this time be carried on in this field by the moneyed interests.

In 1905 the average price of tin was 31.35 cents per pound; in 1906 it rose to 39.81 cents per pound. The world's production of tin in 1906 was 93,919 long tons, or about 500 tons less than in 1905. Of the total production about 47 per cent was used in the United States, with practically no production. These facts alone assure a continuation of the search for tin, especially in a field which has yielded as encouraging results as the York district.

^a Collier, Arthur J., Tin deposits of the York region, Alaska: Bull. U. S. Geol. Survey No. 229, 1904.

^b Hess, Frank L., The York tin region: Bull. U. S. Geol. Survey No. 284, 1906, pp. 145-157.

ANTIMONY.

Stibnite, the sulphide of antimony, has been found at a number of widely separated localities in Alaska, and in view of the constantly increasing demand for antimony it has seemed worth while to call the attention of prospectors to it. In 1906 the price of the metallic antimony increased from 14 and 15 cents to 25 and 26 cents a pound. The consumption of antimony in 1905 for the United States was 5,712 short tons, with no production except some recovered with lead ores. This fact has stimulated the search for commercial ore bodies containing the metal. Antimony finds its principal use in the manufacture of various alloys and in some chemical compounds.

Stibnite is a soft mineral, of a lead or steel-gray color, having a streak of similar color usually with a more or less perfect cleavage visible to the naked eye. This mineral is usually found in veins having a quartz gangue and associated with various other metals. The ore often contains some gold and silver. Of the valuation of the ores Schnatterbeck ^a makes the following statement:

For the information of miners it may be said that smelters pay for ore according to its content of antimony (determined by a fire assay) and its freedom from impurities, such as arsenic, lead, and copper. Ores carrying less than 50 per cent metal are not marketable at present unless they have other unique features which would facilitate smelting. The smelter usually deducts about 30 cents per ton for sampling and weighing ore. In calculating the value of an ore the basis of quotations for metal in London is used, and should the ore exceed 50 per cent metal a premium is allowed, while for every per cent less a discount is exacted.

No ore bodies containing stibnite of proved economic importance have been found in Alaska. The ore is, however, known to occur at the localities mentioned in the following paragraphs:

Antimony ores have been reported from various localities in Seward Peninsula, but the only occurrence known to the writer is on Manila Creek and is described elsewhere in this report (p. 139).

Mr. Prindle reports the occurrence of stibnite in the placers of Cleary and Esther creeks, and he found it in place on Chatham Creek. At the latter locality ^b a vein a foot or more in thickness occurs in the schists.

In the Kantishna region Mr. Prindle found stibnite associated with the auriferous gravels on Eureka and Friday creeks, and in place on Caribou Creek. (See pp. 216, 219.)

^a Schnatterbeck, C. C., The production of antimony in 1905: Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 437.

^b Bull. U. S. Geol. Survey No. 284, 1906, p. 114.

PLACER MINING.

INTRODUCTION.

Of the \$21,600,000 worth of gold produced in Alaska in 1906, nearly \$18,000,000 came from the placers, and more than half of this from the Fairbanks district. Seward Peninsula stands second, with a production of over \$7,500,000, of which at least one-half came from the old beach line. The silver recovered from the placer gold represented in 1906 about two-thirds of the total output of that metal in Alaska, and had a value of about \$60,000.

No new placer districts were discovered in 1906, but the Yentna, Kantishna, and Tenderfoot have become producers since last year. Mining in both Seward Peninsula and the Yukon district was more or less handicapped by the scarcity of water during a part of the open season.

METHODS.

The evolution of placer-mining methods, which is going on continuously, is directed chiefly toward the introduction of machinery in some form. As districts become more accessible the small operator is supplanted by companies with ample financial backing, to bring about a reduction of costs of operation. Moreover, the wasteful methods of the pioneer prospector can find no reward except in the richest and most favorably situated placers, and the gravels of lower value must await better capitalized companies. This change is taking place throughout Alaska, but notably in the Nome region. The most significant feature of this evolution during the last year was the systematic search for placer ground suitable for dredging.

Much has been written on the subject of dredging and its possible application as a mining method in this northern region. Though this is a matter for discussion by the mining engineer rather than by the geologist, a brief statement of a few conditions affecting dredging in this field may be of service to those who are not personally familiar with them. On the one hand, prominent mining engineers have been loud in proclaiming the inapplicability of dredging throughout most of Alaska because of the failure of certain misdirected efforts; on the other, less conscientious promoters have cited the low values profitably recovered by dredging in the Oroville (Cal.) and similar fields as examples of what may be accomplished in Alaska.

From the standpoint of dredging, the Territory may be divided into two provinces, one embracing the area tributary to the Pacific, and the other the placer districts of the Yukon and Seward Peninsula. In the Pacific province there are a number of placer districts which undoubtedly include some good dredging ground, yet in this part of Alaska glacial boulders are not uncommon. Even in glaciated areas, where only easily decomposed rocks, such as mica schist, are present,

large boulders may be exceptional. In general, however, boulders must be expected, since glaciation has been an active agent throughout this province. As a rule the placers of this part of Alaska have not been found to be as rich as those of the Yukon and Seward Peninsula. On the other hand, frost is not encountered in the region tributary to the Pacific except in the Copper River basin and possibly in the upper basin of the Susitna. Other and very important factors in favor of the southern province are its accessibility, relatively cheap fuel, and abundance of water power. In the Yukon and Seward Peninsula districts glaciation is, for the most part, absent and boulders are relatively rare. The values also average much higher, though these vary, of course, locally. Of fundamental importance for consideration in these fields is the large amount of frozen ground which can not be handled by a dredge unless previously thawed. The laws which govern the distribution of the ground ice are not known, so that each placer must be carefully tested on this point before a decision is reached. In general, however, it can be stated as an established fact that the river beds are not frozen, and also that any loose sand or gravel which is well drained is not frozen. The cost of fuel, transportation, and other factors which have been mentioned, vary in different districts of this northern province, but in general are higher than along the Pacific coast. Water power, too, is much rarer than in the southern field. In a comparison of the two provinces it is obvious that the southern field is one where boulders are to be expected, while in the north the presence of frozen ground may so increase the cost of exploitation as to make it prohibitive.

It may be of value to present some facts on the costs and methods of dredging frozen ground, as determined in the Klondike. The writer is indebted to Mr. Albert J. Beaudette, government mining engineer of the Yukon Territory, for the following statement:

The dredge now operating on Bonanza Creek was erected on creek claim No. 42 below Discovery in the year 1901 and afterwards removed to where it is now, on Discovery claim, a distance of about 4 miles farther upstream. It is one of the old type of dredges manufactured in San Francisco, using steam as its motive power. This boat has a theoretical capacity of 1,200 cubic yards per twenty-four hours, but this year it has excavated on an average 700 cubic yards per twenty-four hours for a period of one hundred and twenty-seven days. The capacity of the buckets is $3\frac{1}{4}$ cubic feet, moving with a velocity of 14 to 16 buckets a minute. It requires 65 horsepower to run the dredge.

The great drawback in dredging operations is the "frost," which must be overcome at any cost before the gravel can be excavated and washed. As the plant on the dredge is too small to furnish steam for both the dredge and the points used for thawing, the management had to erect another plant near by to furnish steam for the points. This plant consists of two boilers of 50 horsepower each, 60 points, and pipes to transmit the steam from the boilers to the points at a distance of 25 to 100 feet from the boilers. The points used are from 14 to 16 feet in length and they will thaw the material to the bed rock.

The claims upon which the dredge is being operated have all been worked by the placer method, and it has been found that a great portion of the ground is already thawed and only places where the muck has not been removed are required to be thawed by steam. In the spring the thawing begins fully a month before the dredge is put into operation, and in that way there is always enough ground thawed ahead of the dredge to keep it in operation. The ground is 15 feet to bed rock, consisting nowhere of more than 4 feet of muck and the remainder gravel. The character of the bed rock changes many times in one cross section of the creek from very soft to very hard and slabby, which will affect the duty of the point. The amount of ground that can be thawed by each point varies from 5 to 8 cubic yards in twenty-four hours, according to the amount of muck and the depth to bed rock, the lowest average being 3 feet square of bed rock for a depth of 15 feet to each point.

I here give you concise data about the operations, together with the costs:

Wood used per twenty-four hours.....	cords..	5½
Cost of wood per cord.....		\$13.50
Labor, 2 shifts, 3 men each shift.....		\$40.00
Cubic yards thawed per twenty-four hours.....		400
Cost per cubic yard for thawing.....	cents..	28.5

The above is the expenditure for thawing alone, for which the plant cost about \$4,000.

The figures above given are in a general way applicable to the inland placer districts of Alaska. Costs will, of course, vary according to locality. On Seward Peninsula the operating expenses, as well as the cost of installment of the plant, should be less than these figures.

The question of water supply for hydraulic-mining purposes is still of supreme importance in all the placer districts. At Nome and in other parts of Seward Peninsula the rapid extension of ditches will very soon drain all the streams available for use in hydraulic mining, and then placer-mining operations will cease to expand in this direction. With the cheaper fuel which is likely to come with the utilizing of water powers, other than hydraulic methods will undoubtedly be introduced. In the Yukon camps but little ditch building has taken place, and most of the mining work has been in rich ground, where hydraulic methods are not necessary for profitable exploitation. The deep-lying gravels of the Fairbanks district must always be mined by underground methods, and the only hope of material reduction in costs appears to be in lessening the expense of transportation.

PLACER MINING, BY DISTRICTS.

It is here proposed to summarize the mining developments in the regions which are not more fully treated in other parts of the report. As the following notes are only in part based on the observations of members of the Geological Survey, they must of necessity be ill balanced.

PACIFIC COAST REGION.

Mr. Wright treats of the placers of the Juneau, Porcupine, and Lituya Bay districts in this report (pp. 51, 55, 56, 64, 65). The most noteworthy fact is the small advance made in placer mining in the Porcupine field. An abundance of water and steep gradients, with considerable bodies of gravel, are the favorable conditions in this field, but, on the other hand, the district is handicapped by the ruggedness of the topography and the frequent floods, which often carry away the miners' equipment. The presence of glacial boulders over much of this district is unfavorable to dredging operations. Although the values average much lower than in the Yukon and Seward placers, yet they are within the limits of profitable mining, provided the other difficulties can be overcome.

The beach placers at various places along the seaboard between Lituya Bay and Unga Island yield only a small annual production, but probably give employment every year to half a hundred men. These deposits are of such a character that they can not be mined on any but a small scale. All attempts so far made to exploit them with machinery have met with failure. Yaktag Beach, which is about 60 miles east of Controller Bay, is estimated to have produced about \$25,000 in 1906. About \$10,000 worth of gold has been taken from the beaches of Kodiak and the other islands lying to the southwest.

In the Copper River region the most active placer-mining operations were in the Nizina basin, tributary to the Chitina. This district lies about 200 miles by trail from tide water, and the cost of operations is necessarily very high. It is reported that five claims were operated in the summer of 1906, employing in the aggregate 30 men. In the Chistochina district no rapid progress is reported, but considerable mining was carried on.

The Cook Inlet placers are described elsewhere (pp. 115-124), and it is shown that there has been a decided falling off in output as compared with 1905. The one important advancement is the exploitation of the placers of the Yentna district. The value of the production for 1906 of Cook Inlet and Copper River is estimated to have been \$400,000.

SEWARD PENINSULA.

The Nome district continues to be the mining center of Seward Peninsula, with the Council district as second. Of the production of \$7,500,000 for the entire peninsula, probably 50 per cent must be credited to the third-beach placers near Nome. These two important districts, as well as the Kougarok, are described elsewhere in this report (pp. 126-181). In the lesser districts, such as the Bluestone

and Teller, some developments are being made, but they are entirely overshadowed by the other camps.

In the Fairhaven precinct notable advancements were made, chiefly in ditch building. The Fairhaven Water Company completed the construction of about 30 miles of ditch, which taps Imuruk Lake and which when completed will have a total length of 52 miles and will discharge at Washington Gulch, an easterly tributary of the Inmachuk. The ditch has a capacity of 5,700 miner's inches. A 4-mile ditch is being built at Hannum Creek. A number of surveys have been made, with a view of bringing water to Candle Creek, where the rich bench placers are being worked.

Dry weather prevailed in the Fairhaven district, as in other parts of the peninsula, and hence the largest production was made during the winter months. Considerable gold was taken out of the benches of Candle Creek by winter drifting. The coal mine at Chicago Creek furnishes the fuel for these undertakings. Some rich placer ground was mined on Chicago Creek, and current reports indicate that one claim at this locality was the largest producer of the season. It is also stated on good authority that prospecting in the immediate vicinity of the ground failed to reveal any other workable deposits. Considerable winter work was done on the lower Inmachuk and its tributaries. It seems probable that the value of the production of this camp in 1906 was between \$200,000 and \$300,000, though by some it is stated as high as \$500,000.

YUKON BASIN.

The enormous production of the Fairbanks district, which amounted to over \$9,000,000, overshadowed all other developments in the Yukon basin. The smaller districts all made progress during the year. Of these the most accessible, such as the Rampart, and to a certain degree Birch Creek, naturally received the most attention.

FAIRBANKS.

It is estimated that between 5,000 and 6,000, people were in the Fairbanks district during the summer of 1906. Probably over 50 per cent of these left before the fall freeze-up. A large part of the influx was made up of people with little money or experience in mining, and naturally the expectations of many were doomed to disappointment.

In spite of the prosperous condition, the midsummer saw the camp crowded with men who could find nothing to do. While wages continued high, \$5 to \$6 a day with board, the character of most of the operations made it possible to employ but few inexperienced men. The depth of the alluvium, from 10 to 200 feet, makes prospecting exceedingly costly. Prospect shafts cost \$6 to \$8 a foot, and every pay streak that has been found represents an enormous outlay for

unsuccessful prospecting. Therefore the Fairbanks district proper is eminently not the place for prospectors of small means, but affords splendid opportunities for those with good financial backing. In adjacent areas, however, such as parts of the Tenderfoot district, where the alluvium is much shallower, there are much better chances for the individual miner. It must be remembered that these outlying districts are but little easier of access than they were a few years ago.

There was a great scarcity of water in the Fairbanks district up to the last week in August, after which time there was considerable rain. One of the most favorable features about the Fairbanks district is the fact that the work goes on throughout the year, thus giving steady employment to miners and assuring a more permanent population. In 1906 the summer production was probably not more than 50 per cent of the total.

Means of communication are being rapidly extended. Nearly all the large producing creeks are now connected by wagon roads, either with water transportation on the Tanana, or with the Tanana Mines Railway. This, together with the telegraph and telephone lines, much facilitates business.

Cleary, Fairbanks, Dome, Vault, Esther, Goldstream, and Pedro creeks and their tributaries are the chief producing creeks of the district. Cleary continues to stand first in production, with Fairbanks in second place. The finding of values on Cripple and Treasure creeks definitely extends the producing area to the southwest, and reported discoveries of gold in the upper Chena may show a north-easterly extension of the same belt, though this is not yet established.

The facts in hand are, however, sufficient to determine that there is a gold-bearing zone, at least 10 miles wide, running northeast and southwest, which has been traced for about 30 miles. Its north-eastern extension would intersect the upper Chena basin, while to the southwest it runs out into Tolovana flats. A logical deduction from these facts would suggest that the prospector should turn his attention to the Chena basin and to the streams draining the upland which bounds the Tolovana flats on the east. It should be remembered, however, that the investigations so far made indicate that the conditions which bring about mineralization are local, and hence the formation of placers probably does not persist over any great distance.

Worthy of special note are the rich placers found last year on Vault Creek, which had previously been unproductive. On nearly all the producing streams which are tributary to the Chatanika the pay streak has been traced well down to the main river. In fact, the origin of the rich gravels found in various places at 100 to 200 feet depth under the valley floor of the Chatanika is among the most puz-

zling of the phenomena connected with the placers of this district. Interest in Goldstream Creek was revived during last summer by some rich placer discoveries, and as a result, though the creek was almost abandoned in the early part of the summer, later it was studded with operators for several miles.

Mine operators are rapidly recognizing the necessity of making available all of the water supply tributary to the gold-bearing area. At best the water supply during dry weather is very scant and on some creeks is practically nil. Among the largest ditch-building schemes is that involving the construction of a water main from the upper drainage basins of the Chatanika, for which surveys have been made. It is estimated that this ditch, which is to bring the water of Faith, McManus, Pool, and Smith creeks to the Fairbanks-Cleary divide, will be 72 miles long. It is currently reported that the low-water discharge of these streams is about 5,000 miner's inches at the proposed intake, but these figures the writer has no means of verifying.

Of the outlying districts tributary to Fairbanks the Tenderfoot probably made the largest production, estimated at \$100,000. The gravels on Tenderfoot Creek are deep, but in the smaller creeks are said not to exceed 8 to 10 feet in depth. It would appear that these deposits lie in a different zone from those of Fairbanks.

Some work was done on the streams tributary to the upper Chatanika, where probably 30 men were at work. Some gold has been found on Faith, Hope, and Homestake creeks. The pay streak is thin and the values are said to be regularly distributed.

The region lying south of Fairbanks, including the Bonnifield and Kantishna districts, is described by Mr. Prindle (pp. 205-221), and the Birch Creek district by the writer (pp. 187-204), elsewhere in this report.

RAMPART DISTRICT.

The total gold output of the Rampart district for 1906 is estimated to have a value of \$270,000. The writer is indebted for valuable information to Messrs. H. F. Thumm and E. H. Chapman, of Rampart. Mr. Thumm states that about 33 claims were worked during the winter of 1906 and 17 during the summer, giving employment to about 100 men in winter and about twice as many in summer. New creeks not producing last year are Boothby and Skookum.

Three hydraulic plants were operated during part of the summer, one each on Hoosier, Ruby, and Hunter creeks. The Alaska Road Commission has begun the construction of a highway from Rampart up Big Minook. This when completed will materially reduce the cost of all mining operations.

Another road has been built from Baker Hot Springs to Glenn Creek, a distance of 24 miles, by Thomas Manley, a large owner of mining

property. This road affords a natural outlet to Tanana River for the Glenn Creek region. Mr. Manley has also surveyed a ditch line from Hutlinana Creek to Thanksgiving Creek, a distance of 15 miles. If the scheme is carried out and there is sufficient water it will lead to extensive mining developments in the Glenn Creek region. It is of interest to note that the same operator has imported a churn drill for prospecting, the first in the district.

KOYUKUK DISTRICT.

Little information is at hand regarding the remote Koyukuk district, but it is reported that the gold production in 1906 was about \$150,000 or \$200,000. There has been no reduction in cost of operations, and until such takes place there will probably be no expansion of the mining. It is said that there are about 200 men in the Koyukuk district, and that the richest placers are on Newlands Creek. During the past winter a stampede took place on Johns River, but it appears that nothing of value was found.

Late in the summer of 1906 a report came to Fairbanks of the discovery of new placer ground in the Chandlar basin. The Chandlar is tributary to the Yukon from the northwest about 20 miles below Fort Yukon. Auriferous gravels have long been known to occur in this region,^a but no workable placers have previously been found. A stream called Big Creek is reported to be the scene of the new find.

FORTY MILE REGION.^b

The area usually included under the name Fortymile region embraces the basin of Fortymile River as well as the placer district tributary to the town of Eagle. Though the oldest of the Yukon camps, progress has been very slow, chiefly because of the lack of transportation facilities. This is being remedied to a certain extent by the construction of a wagon road to Steele Creek.

Upward of 200 men are working in this district, probably on half as many claims. The principal producing creeks are Jack Wade, Chicken, and Lost Chicken, together with their tributaries. The producing creeks in the region tributary to Eagle include several confluent to Seventymile Creek, together with American Creek and some smaller streams.

Considerable interest has been taken in the Fortymile region in the subject of dredges, but no plants have yet been set up. There are also plans for ditch building, but these have not gone beyond preliminary surveys.

^a Schrader, F. C., Preliminary report on a reconnaissance along Chandlar and Koyukuk rivers: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1900, pp. 341-423.

^b The writer is indebted to Messrs. Elmer R. Brady, commissioner at Jack Wade, and U. G. Myers, commissioner at Eagle, for information about the Fortymile region.

The writer is indebted to C. B. McDowell, of the Fortymile region, Alaska, for the following statement in regard to the developments in that district:

As dredging has proved so successful in the Klondike, many efforts are being initiated here looking toward working this section in a similar manner. Russell King, of London, has purchased several miles of Walkers Fork and is now installing a 5-foot bucket dredge on the properties. He expects to begin operations in the early part of June. The McDowell-Allen Company is also installing a dipper dredge on South Fork of Fortymile River and likewise expects to begin operations early in the summer. A company installed a dredge on the Canadian side of Fortymile River late last summer and will work its ground in this fashion the coming summer. Another dredge is now being installed at the boundary on the Fortymile for operations this summer. G. L. Savage, of New York, began operations late last fall on a ditch line to carry water from Mosquito Fork into the Chicken Creek basin for hydraulic purposes. Considerable prospecting for quartz was carried on last year, and while there were two good surface showings found—one gold and one copper—sufficient work has not yet been done to demonstrate whether they are of any great value or not.

According to the statement of J. H. Van Zandt, deputy collector at Fortymile, 11,974 ounces of gold were shipped through his office in 1906. The entire production of this district in 1900 is estimated to have a value of \$300,000.