THE ALASKAN MINING INDUSTRY IN 1921.

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GENERAL FEATURES.

The value of the total mineral production of Alaska in 1920 was $23,303,757; the value in 1921 was $17,004,124. Yet in spite of this tremendous falling off, the mining industry as a whole can be said to have been more prosperous in 1921 than in 1920. The decrease in value is due to the low price of copper, and no advance of the Alaska copper-mining industry can be expected until there is a better market for the metal. Coal mining shows some growth, though it remains to be proved that Alaska high-grade coal will in the near future be mined for export. The search for Alaska oil fields was vigorously continued in 1921, though except at Katalla there has yet been no drilling. As will be shown, the placer-mining industry in 1921 had a prosperous growth, compared with that of previous years. The most important event of the year to the future of the mining industry was the practical completion of the Alaska Railroad (the Government line). There only remains to be built the bridge across Tanana River. The building of roads in Alaska was expedited during the year, so far as the funds available permitted. There is good reason to believe that the ocean transportation service to Alaska is soon to be improved. These betterments of means of communication are the most valuable local factors in promoting the revival of Alaska mining.

The dominant features of the year's mining are (1) the decrease of both copper production and development, owing to the low price of the metal; (2) the closing of the Perseverance mine, one of the three large auriferous lode mines at Juneau; (3) continuation of activity in auriferous quartz development in the Sitka, Juneau, Salmon River, and Willow Creek districts; (4) a revival of placer mining; (5) continuation of systematic prospecting for coal in the Matanuska field by the Naval Coal Commission; (6) the many examinations made in Alaska petroleum fields by oil companies, with the purpose of drilling. The discovery of a new locality of galena and other sulphide deposits in the Kantishna district is also worthy of special note.

The number of men engaged each year in productive mining gives a rough measure of the prosperity of the industry, but unfortunately complete statistics are not available. A careful study of all the facts at hand appears to justify the following estimates, which include only the men employed at mines that made some mineral output during the year.

Estimates of number of men employed at productive mines of Alaska, 1911–1921.

Year.	Placer mines.		Lode mines and reduction plants.	All other mining and quarrying.	Total men engaged in mining, not including winter placer mines.
	Summer.	Winter (omitted from total).			
1911	4,900	670	2,360	150	7,410
1912	4,500	900	2,560	150	7,210
1913	4,500	800	3,450	140	8,090
1914	4,400	800	3,500	140	8,040
1915	4,400	700	3,850	160	8,410
1916	4,050	880	4,570	340	8,960
1917	3,550	950	3,220	270	7,040
1918	3,000	610	2,000	400	5,400
1919	2,180	320	1,900	310	4,390
1920	1,990	340	1,880	360	4,230
1921	2,150	555	1,450	400	4,000

In considering the above table it should be remembered that the summer placer mines are operated for an average period of less than 100 days in a year. A comparison of the first two columns shows that only a small percentage of the men engaged in summer placer mining can find similar employment in the winter. As the winter placer mining is all done through shafts and drifts it is closely related to lode mining. Some of the deep placer mines are operated for nearly the entire year and hence are included in the total summer mines also. The lode mines include copper and gold and a few other metal mines, and the figures for these include only the average number employed during the year. The fourth column shows the number of men engaged in all other forms of mining and quarrying, including the exploitation of coal, petroleum, marble, tin, gypsum, and other products.

Mineral output of Alaska, 1920 and 1921.

	1920		1921		Decrease or increase in 1921.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	404,683	$8,365,560	390,558	$8,073,540	− 14,126	− $292,020
Copper.....pounds..	70,435,363	12,960,106	57,011,597	7,354,496	−13,423,766	−5,605,610
Silver.....fine ounces..	953,546	1,039,364	761,085	761,085	− 192,461	−278,279
Coal.....short tons..	61,111	355,668	76,817	496,394	+ 15,706	+ 140,726
Tin, metallic.....do....	16	16,112	4	2,400	− 12	− 13,712
Lead.....do....	875	140,000	759	68,279	− 116	− 71,721
Platinum metals .....fine ounces..	1,478.97	160,117	40	2,670	− 1,438.97	− 157,447
Miscellaneous nonmetallic products, including petroleum, marble, gypsum, and quicksilver....	.....	266,830	.....	245,260	.....	− 21,570
	.....	23,303,757	.....	17,004,124	.....	−6,299,633

Value of total mineral production of Alaska, 1880–1921.

By years.				By substances.	
1880–1890	$4,686,714	1907	$20,850,235	Gold	$328,104,093
1891	916,920	1908	20,145,632	Copper	134,840,698
1892	1,098,400	1909	21,146,953	Silver	8,103,977
1893	1,051,610	1910	16,887,244	Coal	2,292,522
1894	1,312,567	1911	20,691,241	Tin	936,664
1895	2,388,042	1912	22,536,849	Lead	730,537
1896	2,981,877	1913	19,476,356	Antimony	237,500
1897	2,540,401	1914	19,065,666	Marble, gypsum, petroleum, platinum, etc	3,232,922
1898	2,587,815	1915	32,854,229		478,478,913
1899	5,706,226	1916	48,632,212		
1900	8,241,734	1917	40,710,205		
1901	7,010,838	1918	28,253,961		
1902	8,403,153	1919	19,620,913		
1903	8,944,134	1920	23,303,757		
1904	9,569,715	1921	17,004,124		
1905	16,480,762		478,478,913		
1906	23,378,428				

GOLD AND SILVER.

TOTAL PRODUCTION.

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

Gold and silver produced in Alaska, 1880–1921.

Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Commercial value.
1880	967	$20,000		
1881	1,935	40,000		
1882	7,256	150,000		
1883	14,561	301,000		
1884	9,724	201,000	10,320	$11,146
1885	14,512	300,000		
1886	21,575	446,000		
1887	32,653	675,000		
1888	41,119	850,000	2,320	2,181
1889	43,538	900,000	8,000	7,490
1890	36,862	762,000	7,500	6,071
1891	43,538	900,000	8,000	7,920
1892	52,245	1,080,000	8,000	7,000
1893	50,213	1,038,000	8,400	6,570
1894	62,017	1,282,000	22,261	14,257
1895	112,642	2,328,500	67,200	44,222
1896	138,401	2,861,000	145,300	99,087
1897	118,011	2,439,500	116,400	70,741
1898	121,760	2,517,000	92,400	54,575
1899	270,997	5,602,000	140,100	84,276
1900	395,030	8,166,000	73,300	45,494
1901	335,369	6,932,700	47,900	28,598
1902	400,709	8,283,400	92,000	48,590
1903	420,069	8,683,600	143,600	77,843
1904	443,115	9,160,000	198,700	114,934
1905	756,101	15,630,000	132,174	80,165
1906	1,066,030	22,036,794	203,500	136,345
1907	936,043	19,349,743	149,784	98,857
1908	933,290	19,292,818	135,672	71,906
1909	987,417	20,411,716	147,950	76,934
1910	780,131	16,126,749	157,850	85,239
1911	815,276	16,853,256	460,231	243,923
1912	829,436	17,145,951	515,186	316,839
1913	755,947	15,626,813	362,563	218,988
1914	762,596	15,764,259	394,805	218,327
1915	807,966	16,702,144	1,071,782	543,393
1916	834,068	17,241,713	1,379,171	907,495
1917	709,049	14,657,353	1,239,150	1,021,060
1918	458,641	9,480,952	847,789	847,789
1919	455,984	9,426,032	629,708	705,273
1920	404,683	8,365,560	953,546	1,039,364
1921	390,558	8,073,540	761,085	761,085
	15,872,034	328,104,093	10,733,647	8,103,977

Gold and silver produced in Alaska, 1921, by sources.

	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.
Siliceous ores (2,894,813 short tons)	184,707	$3,818,226	99,515	$99,515
Copper ores (477,121 short tons)	1,329	27,471	545,229	545,229
Lead ores (727 short tons)	89	1,843	93,766	93,776
Placers (4,812,721 cubic yards of gravel)	204,433	4,226,000	22,565	22,565
	390,558	8,073,540	761,085	761,085

Gold and silver produced in Alaska from different sources, 1880–1921.

	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.
Siliceous ores [a]	4,847,738	$100,211,663	1,868,163	$1,514,879
Copper ores	86,128	1,780,438	7,043,148	5,502,063
Placers	10,938,168	226,111,992	1,822,336	1,087,035
	15,872,034	328,104,093	10,733,647	8,103,977

[a] Including small amounts of lead ore.

LODE MINING.

Nineteen gold and silver lode mines and thirteen prospects [1] were operated in 1921 and produced gold, silver, and some lead and copper to a total value of $4,082,741; in 1920 seventeen gold and silver lode mines and five prospects were operated and produced metals to a total value of $4,886,547. This decrease in metallic output of the Alaska lode mines is due to the closing in June of the Perseverance mine, in the Juneau district. In general the lode-mining industry of 1921 showed progress during the year, but developments of ore bodies are not yet sufficient to give any assurance that output of gold from this source will increase in the immediate future. At the end of the year there were only three large productive mines in southeastern Alaska, and for the present the maintenance of Alaska's gold-lode production depends on these three mines. On the other hand, some progress was made during 1921 in lode mining in the Willow Creek district, where the gold output was nearly double that of 1920. It must be noted, however, that no noteworthy reserves of gold ore have yet been developed in the Willow Creek district, though the outlook for finding them is encouraging. The silver-lead deposits of the Kantishna region are promising. Lode mining at Fairbanks has increased in a small way, and the present accessibility of the district by rail will undoubtedly stimulate further search for commercial ore bodies.

[1] Lode properties the value of whose total metallic output is less than $1,000 are here classed as prospects. These include some mines on which considerable development work has been done, but which have not yet been put on a regular productive basis.

Though the developed gold-ore reserves in Alaska are small, the discovery of promising auriferous lodes in so many widely separated localities and the known widespread favorable geologic conditions for the bedrock occurrence of gold are auspicious for a large lode gold-mining development. Silver-bearing galena ores are also widespread in Alaska. Thus far mining of such deposits has been confined to the extraction of small but very rich ore shoots. There is good hope, though as yet no positive evidence, that larger galena ore bodies will be found and that the exploitation of such bodies may become a more permanent feature of Alaska metal mining than at present. Meanwhile the small shipments of galena ores rich in silver have greatly swelled the silver output derived from Alaska lode deposits, as shown in the following table:

Gold and silver produced from gold lode mines in Alaska in 1921, by districts.

District.	Ore mined (short tons).	Gold.		Silver.		Average value per ton of ore in gold and silver.
		Fine ounces.	Value.	Fine ounces.	Value.	
Southeastern Alaska	2,889,752	176,158.62	$3,641,522	102,070	$102,070	$1.29
Willow Creek	3,591	5,721.50	118,273	1,029	1,029	33.22
Fairbanks district	944	1,858.27	38,414	279	279	40.99
Other districts	1,253	1,057.53	21,860	89,913	89,913	89.20
	2,895,540	184,795.92	3,820,069	193,291	193,291	1.39

In the above table are included the silver-lead ores, as well as auriferous quartz. The ore hoisted from the auriferous quartz mines yielded on the average $1.39 worth of gold and silver to the ton. In 1920 the average recovery was $1.39, and in 1919 it was $1.38. It is needless to state that this low recovery is caused by the large percentage of the total tonnage mined that is to be credited to the mines of the Juneau district.

PLACER MINING.

During 42 years of mining Alaska has produced gold to the value of $328,104,093, and of this amount $226,112,000 is to be credited to her placer mines. Because of the high cost of all mining operations and the relatively low purchasing value of gold that have existed since the war gold placer mining has been on the decline. During this period of stagnation Alaska placer mining has been maintained chiefly by those who had large plants, such as dredges and hydraulic mines, and could not afford to let them rest idle. A very large percentage of the mines were operated by the owners, who had no other means of livelihood and were loath to leave the country and take up a new vocation. In 1921 there was a marked improvement in the placer-mining industry, which was expressed not only by an increase

of about 9 per cent in the gold output but also in the number of large placer-mining projects that are under way. This revival is due to a general lowering of costs in the more accessible districts, though the costs are still very high. A considerable number of the smaller placer mines are being operated at a loss. Costs will undoubtedly be lowered in the region served by the Alaska Railroad, and when water transportation on Yukon River is adjusted to the new conditions produced by the railroad to Fairbanks, operating costs will also decline in some of the more isolated Yukon camps. The transportation furnished by the Alaska Railroad can not, however, be made available to the inland mining industry unless a very liberal policy of wagon-road construction is adopted. The construction of roads and trails is to-day the greatest need of the Alaska mining industry. The Alaska Road Commission is fully aware of this need and has accomplished much with the funds at its disposal.

The quantity of incoming freight required for placer mining varies greatly according to methods of mining and sources of fuel and lumber, but precise figures on this subject are not available. It is evident that in districts where placer mining is the only industry all the incoming freight is chargeable to this industry. The facts at hand indicate a more or less constant relation between the amount of annual incoming freight and the annual gold output, though manifestly the richer the ground the more gold will be produced to the ton of incoming freight. At Fairbanks the average of eight years showed that about $380 worth of placer gold was produced for each ton of incoming freight. This freight included, however, practically no fuel or lumber. The average of the Yukon camps was about $530 worth of placer gold for each ton of freight. In the smaller districts like Koyukuk, Iditarod, and Hot Springs, where very rich placer deposits were being exploited, from $500 to $1,000 worth of gold was produced for each ton of freight. The mining of the low-grade placers of Seward Peninsula, where it is necessary to import all fuel and lumber, in the two years 1919 and 1920 produced only $130 worth of gold for every ton of freight brought in. The figures given above, though only approximately accurate, clearly show how the cost of transportation is the dominating factor in placer mining.

A number of new finds of placer gold were made during 1921, but they were all in known fields of auriferous alluvium. One of these discoveries was made on Wilbur Creek, a tributary of Tolovana River, about 7 miles due east of Livengood Creek. The finding of coarse gold on this creek indicates that there may be a second belt of mineralization in the Tolovana area. Another deposit of placer gold was found on Kokomo Creek, a southerly tributary of Chatanika River, 10 miles east of Cleary. This discovery is significant chiefly because it indicates an eastern extension of the auriferous area. In 1921

placer mining was begun on gold prospects that had been found in 1918 on Stuyahok Creek, a tributary of Bonasila River, which flows into the Yukon 10 miles below Anvik. Prospecting in the Chandalar district has given specially encouraging results, and the output from this camp will probably increase. In general the outlook is favorable for an increase of placer-gold output in 1922.

Statistics of Alaska placer mining in 1920 and 1921.

Region.	Number of mines.				Number of miners.				Value of gold produced.		
	Summer.		Winter.		Summer.		Winter.		1920	1921	Decrease or increase, 1921.
	1920	1921	1920	1921	1920	1921	1920	1921			
Southeastern and southwestern Alaska	18	7	.....	3	18	11	.....	3	$10,000	$4,000	−$6,000
Copper River region	19	7	.....	2	94	130	.....	14	200,000	220,000	+20,000
Cook Inlet and Susitna region	27	34	.....	2	70	144	.....	29	55,000	165,000	+110,000
Yukon Basin	273	334	69	79	1,130	1,131	271	335	1,995,000	1,860,000	−135,000
Kuskokwim region	32	28	.....	3	125	98	.....	8	305,000	520,000	+215,000
Seward Peninsula	112	126	8	13	540	622	61	61	1,300,000	1,450,000	+150,000
Kobuk region	7	9	5	4	10	15	9	10	8,000	7,000	−1,000
	488	545	82	106	1,987	2,151	341	460	3,873,000	4,226,000	+353,000

Gold and silver produced from placer mines in Alaska in 1921, by regions.

Region.	Gold.		Silver.		Gravel mined (cubic yards).	Recovery per cubic yard.
	Fine ounces.	Value.	Fine ounces.	Value.		
Southeastern and southwestern Alaska	193.50	$4,000	33	$33	2,283	$1.75
Copper River region	10,642.50	220,000	1,110	1,110	341,183	.64
Cook Inlet and Susitna region	7,981.87	165,000	1,164	1,164	347,423	.47
Yukon Basin	89,977.50	1,860,000	11,952	11,952	1,574,546	1.18
Kuskokwim region	25,155.00	520,000	2,959	2,959	195,529	2.66
Seward Peninsula	70,143.75	1,450,000	5,307	5,307	2,347,418	.62
Kobuk region	338.63	7,000	40	40	4,339	1.61
	204,432.75	4,226,000	22,565	22,565	4,812,721	.88

Hydraulic mining is becoming of constantly increasing importance in the Alaska placer industry, and this accounts in part for the lowering of the average value of the gold recovery to the cubic yard from the gravel sluiced annually. As yet there are but few large hydraulic plants in operation. Conditions favorable for hydraulic mining on a large scale, such as proper stream gradients, water supply under sufficient head, and large bodies of auriferous gravel, are found in the mountainous belt that borders the Pacific Ocean and extends inland for 150 to 200 miles. The Porcupine, Nizina, Chistochina, Valdez Creek, Yentna, Kantishna, Bonnifield, and Chisna placer districts lie within or on the border of this mountainous belt. As yet no con-

siderable tests of the larger bodies of auriferous gravel lying within this belt have been made to determine their gold content. Some of these deposits are well worth thorough prospecting.

The following table is based in part on returns made by operators of placer mines and in part on known facts or assumptions concerning the richness of the gravel in the several districts. Although the table is thus in part an estimate it is probably nearly correct.

The decline in the average gold content of the gravels mined from 1908 to 1914 reflects the gradual exhaustion of bonanza placers, the improvement of methods of placer mining, and the increased use of dredges.

Gravel sluiced in Alaskan placer mines and value of gold recovered, 1908–1920.

Year.	Total quantity of gravel (cubic yards).	Value of gold recovered per cubic yard.	Year.	Total quantity of gravel (cubic yards).	Value of gold recovered per cubic yard.
1908	4,275,000	$3.74	1915	8,100,000	$1.29
1909	4,418,000	3.66	1916	7,100,000	1.57
1910	4,036,000	2.97	1917	7,000,000	1.40
1911	5,790,000	2.17	1918	4,931,000	1.20
1912	7,050,000	1.70	1919	4,548,000	1.10
1913	6,800,000	1.57	1920	3,439,900	1.13
1914	8,500,000	1.26	1921	4,812,700	.88

Relation of recovery of placer gold per cubic yard to proportion produced by dredges.

Year.	Percentage of placer gold produced by dredges.	Recovery per cubic yard.		
		Dredges.	Mines.	All placers.
1911	12	$0.60	$3.36	$2.17
1912	18	.65	2.68	1.70
1913	21	.54	3.11	1.57
1914	22	.53	2.07	1.26
1915	22	.51	2.33	1.29
1916	24	.69	2.64	1.57
1917	26	.68	2.21	1.40
1918	24	.57	1.84	1.20
1919	27	.77	1.31	1.10
1920	29	.69	1.53	1.13
1921	37	.57	1.31	.88

As shown in the subjoined list, 24 dredges were operated in Alaska in 1921, as compared with 22 in 1920. Three of these machines were operated less than a month and therefore should not be classed with the normal producers. The Seward Peninsula dredges were in commission 90 to 121 days, averaging about 100 days of productive mining. The dredges of the Yukon and Kuskokwim region worked from 90 to 145 days. The average gold recovery for all Alaska dredges was 57 cents a cubic yard; for the Yukon and Kuskokwim dredges, 90 cents; and for Seward Peninsula, 39 cents. There is good reason to believe that two or three additional dredges will be in operation in 1922.

Gold dredges operated in Alaska in 1921.

Seward Peninsula:
- Council district:
  - Crooked Creek Dredge Co., Crooked Creek.
  - Garrod & Pfaffle, Warm Creek (?).
  - Northern Light Mining Co., Ophir Creek.
  - Wild Goose Mining & Trading Co. (2 dredges), Ophir Creek.
- Kougarok district:
  - Behring Dredging Corporation, Kougarok River.
  - Kougarok Mining Co., Kougarok River (?).
- Nome district:
  - Ames & Guinan, Glacier Creek.
  - Center Creek Dredging Co., Snake River.
  - Dexter Creek Dredging Co., Dexter Creek.
  - Dry Creek Dredging Co., Dry Creek.
  - Julien Dredging Co., Osborn Creek.
- Port Clarence district:
  - C. F. & F. L. Rice, Swanson Creek.
- Solomon district:
  - Eskimo Gold Dredging Co., Solomon River.
  - Iverson & Johnson, Big Hurrah Creek.
  - Shovel Creek Dredging Co., Shovel Creek.

Yukon basin:
- Circle district:
  - Berry Dredging Co., Mastodon Creek.
- Fraibanks district:
  - Fairbanks Gold Dredging Co. (2 dredges), Fairbanks Creek.
- Iditarod district:
  - Beatson & Donnelly, Otter Creek.
  - J. E. Riley Investment Co., Otter Creek.
- Innoko district:
  - Flume Dredge Co., Yankee Creek.

Kuskokwim region:
- Mount McKinley district:
  - Kuskokwim Dredging Co., Candle Creek.

Cook Inlet and Susitna region:
- Yentna district:
  - Cache Creek Dredging Co., Cache Creek.

Gold produced by dredge mining in Alaska, 1903–1921.

Year.	Number of dredges operated.	Value of gold output.	Gravel handled (cubic yards).	Value of gold recovered per cubic yard.
1903	2	$20,000	.....	.....
1904	3	25,000	.....	.....
1905	3	40,000	.....	.....
1906	3	120,000	.....	.....
1907	4	250,000	.....	.....
1908	4	171,000	.....	.....
1909	14	425,000	.....	.....
1910	18	800,000	.....	.....
1911	27	1,500,000	2,500,000	$0.60
1912	38	2,200,000	3,400,000	.65
1913	35	2,200,000	4,100,000	.54
1914	42	2,350,000	4,450,000	.53
1915	35	2,330,000	4,600,000	.51
1916	34	2,679,000	3,900,000	.69
1917	36	2,500,000	3,700,000	.68
1918	28	1,425,000	2,490,000	.57
1919	28	1,360,000	1,760,000	.77
1920	22	1,129,932	1,633,861	.69
1921	24	1,582,520	2,799,519	.57
	.....	23,107,452	.....	.....

COPPER.

The total copper output of Alaska in 1921 was 57,011,597 pounds, valued at $7,354,496; in 1920 it was 70,435,363 pounds, valued at $12,960,106. This decrease in output was the result of curtailment of production at the four large Alaska copper mines—the Kennecott-Bonanza, Jumbo, and Mother Lode, in the Chitina basin, and the Beatson-Bonanza, on Prince William Sound—and was but a reflection of the world-wide depression in the copper-mining industry. The Rush & Brown mine, in the Ketchikan district, is the only other Alaska copper mine that was operated on a productive basis throughout the year. There was, however, a small copper output from half a dozen other localities in Alaska during 1921.

Besides the copper the 477,121 tons of ore from the copper mines yielded 1,328.91 fine ounces of gold, valued at $27,471, and 545,229 fine ounces of silver, valued at $545,229.

The average copper content of the ore mined in 1921 was 5.8 per cent; in 1920 it was 4.6 per cent. The gold and silver content of the Alaska copper ores varies so greatly that the average is not significant. Of the total copper ore mined 448,236 tons was concentrated, yielding 47,571 tons of concentrates, which averaged 35 per cent of copper. Most of the copper concentrates and crude ore were shipped to the smelter at Tacoma, Wash.

Copper produced in Alaska, 1880–1921.

Year.	Mines operated.	Ore mined (tons).	Copper produced.	
			Pounds.	Value.
1880	1		3,393	$826
1901	2		250,000	40,000
1902	3	a 40,000	360,000	41,400
1903	4		1,200,000	155,000
1904	5		2,043,586	275,676
1905	8	52,199	4,805,236	749,617
1906	15	105,729	5,871,811	1,133,260
1907	13	98,927	6,308,786	1,261,757
1908	9	51,509	4,585,362	605,267
1909	7	34,669	4,124,705	536,211
1910	7	39,365	4,241,689	538,695
1911	8	68,975	27,267,878	3,408,485
1912	7	93,452	29,230,491	4,823,031
1913	6	135,756	21,659,958	3,357,293
1914	6	153,605	21,450,628	2,852,934
1915	14	369,600	86,509,312	15,139,129
1916	18	617,264	119,854,839	29,484,291
1917	17	659,957	88,793,400	24,240,598
1918	17	722,047	69,224,951	17,098,563
1919	8	492,644	47,220,771	8,783,063
1920	8	766,095	70,435,363	12,960,106
1921	6	477,121	57,011,597	7,354,496
	.....	4,978,914	672,454,296	134,840,698

a Estimated.

Though underground exploration of copper lodes continued in a small way in all the Alaska copper districts no important advances can be recorded. At no time in its history has the Alaska copper-mining industry been so stagnant as it was in 1921. Most of the copper properties are in the hands of those who have not sufficient capital to permit systematic underground exploration. Their activities are usually limited to the required assessment work or to the search for and development of rich ore shoots that can be exploited at a profit, even by those of small financial resources. Such small activities can not lead to profitable mining unless the ore body is close to railroads or ocean transportation.

The record that there were only six productive copper mines in all Alaska in 1921, on its face, would certainly lead to dismay, yet some other facts in regard to the occurrence of copper are encouraging. The wide distribution of copper ores in Alaska has already been fully described.[2] There are in Alaska some 28 mines which have in the past produced copper on a commercial scale. The suspension of operations at some of these mines is due to the apparent exhaustion of the ore bodies, but in much the larger number it is due to other factors. The reopening of many of these mines is dependent on the availability of capital, notably for concentrating plants, on cheap transportation, and, above all, on a higher price of copper.

Copper mineralization has occurred at hundreds of localities, and the location of claims on very small showings is a common practice. The number of copper claims that have been staked therefore affords no measure of the number of commercial deposits. A careful weighing of the information at hand indicates that there are in Alaska within 25 miles of a railroad or of tidewater at least 65 copper prospects that give hope of containing commercial ore bodies. Therefore, although the evidence in hand is far from being conclusive, it appears that, including mines and accessible prospects, there are about 100 localities where there are copper ore bodies that have some promise of being of commercial size. These do not include the deposits of copper at localities now too remote to permit development without large investments in railroad construction.

LEAD.

The lead produced in Alaska in 1921 came from the gold ores of the Juneau district and from galena ores mined for their high silver content, chiefly in the Kantishna and Ruby districts of the Yukon and the Fairhaven district of Seward Peninsula. A total of 727 tons of these silver-lead ores was shipped in 1921 and yielded on the average 129 ounces of silver to the ton and 35 per cent of lead. In-

[2] Brooks, A. H., The future of Alaska mining: U. S. Geol. Survey Bull. 714, pp. 12-36, 1921.

cluding the small content of gold and copper, the average value of these silver-lead ores was $164 a ton.

All this mining was limited to the extraction of rich ore shoots, for the cost of transportation has thus far prohibited the exploitation of ore of lesser metallic content. The search for such valuable silver-lead deposits has brought additional evidence of the widespread occurrence of galena ores in Alaska. In the Kantishna district some indications have been found of the presence of larger ore bodies than have thus far been exploited.

Lead produced in Alaska, 1892–1921.

Year.	Tons.	Value.	Year.	Tons.	Value.
1892	30	$2,400	1908	40	$3,360
1893	40	3,040	1909	69	5,934
1894	35	2,310	1910	75	6,600
1895	20	1,320	1911	51	4,590
1896	30	1,800	1912	45	4,050
1897	30	2,160	1913	6	528
1898	30	2,240	1914	28	1,344
1899	35	3,150	1915	437	41,118
1900	40	3,440	1916	820	113,160
1901	40	3,440	1917	852	146,584
1902	30	2,460	1918	564	80,088
1903	30	2,520	1919	687	72,822
1904	30	2,580	1920	875	140,000
1905	30	2,620	1921	759	68,279
1906	30	3,420			
1907	30	3,180		5,818	730,537

TIN.

On account of the low price of tin, operations in the York district of Seward Peninsula, the only region in Alaska where commercial deposits of this metal have been found, were suspended in 1920. The only tin produced during the year was a few tons won from gold placer-mining operations in the Hot Springs district of the Yukon basin. No tin was shipped from Alaska in 1921.

Tin produced in Alaska, 1902–1921.

Year.	Ore (tons).	Metal (tons).	Value.	Year.	Ore (tons).	Metal (tons).	Value.
1902	25	15	$8,000	1913	98	50	$44,103
1903	41	25	14,000	1914	157.5	104	66,560
1904	23	14	8,000	1915	167	102	78,846
1905	10	6	4,000	1916	232	139	121,000
1906	57	34	38,640	1917	171	100	123,300
1907	37.5	22	16,752	1918	104.5	68	118,000
1908	42.5	25	15,180	1919	86	56	73,400
1909	19	11	7,638	1920	26	16	16,112
1910	16.5	10	8,335	1921	7	4	2,400
1911	92.5	61	52,798				
1912	194	130	119,600		1,607.0	992	936,664

PLATINUM METALS.

The output of platinum minerals in Alaska in 1921 showed a large falling off, owing to the suspension of operations at the Salt Chuck mine, which in the past has been the principal producer of palladium in Alaska. The platinum produced in 1921 was won entirely as a by-product of gold placer mining. The producers include one mine on Slate Creek, in the Chistochina district of the Copper River basin; three on Dime Creek and one on Sweepstake Creek, both in the Koyuk district of Seward Peninsula; and one on Bear Creek, in the Fairhaven district of Seward Peninsula. This record shows that the mining of placer platinum is not yet an established industry in Alaska, for its continuance is dependent on the recovery of placer gold. The total production of platinum metals in Alaska since they were first saved in 1916 is shown in the following table:

Platinum metals produced in Alaska, 1916–1921.

Year.	Crude ounces.	Fine ounces.	Value.	Year.	Crude ounces.	Fine ounces.	Value.
1916	12.0	8.33	$700	1920	1,493.4	1,478.97	$160,117
1917	81.2	53.40	5,500	1921	57.0	40.0	2,670
1918	301.0	284.00	36,600				
1919	579.3	569.52	73,663		2,523.9	2,434.22	279,250

QUICKSILVER.

The only quicksilver deposits thus far developed in Alaska occur in the lower Kuskokwim region and in the adjacent part of the basin of Iditarod River, which flows into the Yukon. For many years the Parks mine, on the banks of Kuskokwim River, was the only producer of quicksilver in Alaska. This mine was not productively operated in 1921, but some underground work was done. Developments were also continued on the adjacent Willis & Fuller's quicksilver claim. More important operations were conducted by the Thrift Mining Co. on cinnabar-bearing lodes on Montana Creek, a tributary of the upper Iditarod. This property has not been visited by the Geological Survey. The company reports that the vein on which work is being done is 3 feet 8 inches wide and that other promising cinnabar veins occur on the property. The cinnabar is now being treated in a four-tube retort, but a larger reduction plant is planned. This is the only property in Alaska on which quicksilver was produced in 1921.

MISCELLANEOUS METALS.

Antimony, tungsten, and chromite deposits in Alaska were mined during the World War, but this work ceased with the coming of peace. Only assessment work is now being done on lodes carrying

these metals. In 1921 no development work, except that required by law, was done on Alaska deposits of nickel, molybdenite, and bismuth.

COAL.

Of the output of coal in Alaska during 1921, 53,088 tons came from the three Government mines in the Matanuska field. The total production of bituminous coal in 1921 was 58,078 tons; of lignitic coal, 18,739 tons. As shown by the subjoined table, Alaska coal mines do not yet supply the local consumption.

In 1921 there were 15 localities in Alaska where some coal was produced, but at only 7 of these did the total output exceed 1,000 tons, and of these 3 were Government mines. Of the 4 private mines producing more than 1,000 tons, 3 produced lignitic coal and 1, the Evan Jones, in the Matanuska field, subbituminous coal. The 15 mines, large and small, employed 401 men for an average of 231 days of the year. Of these men, about 150 were employed by the Naval Coal Commission, and a large part of these were engaged in development work and not in productive mining.

The most important events in the Alaska coal-mining industry in 1921 were the building of a Government coal washery and the opening of the Coal Creek mine, in the Matanuska field, by the Naval Coal Commission, and the systematic development of the Evan Jones mine, in the same field, and of the Healy mine, in the Nenana lignitic field. The last two, though operated only on a small scale, are the first private enterprises that have reached the stage of systematic production of Alaska coal. Their success brings the final proof that the Alaska coal can be utilized to supply the needs of the Territory. As Alaska is still using some 58,000 tons of imported coal, there is room for expansion on the basis of the present local market. Moreover, the lower cost of the local coal will undoubtedly lead to industrial developments that will produce a still larger demand. It should be noted, however, that in supplying such regions as Nome and Seward Peninsula the Alaska fields thus far opened up have no advantage in transportation over those that furnish the imported coals. In 1921 about 19,000 tons of coal was shipped to Nome.

Coal produced and consumed in Alaska, 1888–1921, in short tons.

Year.	Produced in Alaska, chiefly subbituminous and lignite.		Imported from States, chiefly bituminous from Washington.[a]	Total foreign coal, chiefly bituminous from British Columbia.[a]	Total coal consumed.
	Short tons.	Value.			
1888–1896	6,000	$84,000	.....	.....	.....
1897	2,000	28,000	.....	.....	.....
1898	1,000	14,000	.....	.....	.....
1899	1,200	16,800	10,000	[b] 50,120	61,320
1900	1,200	16,800	15,048	[b] 56,623	72,871
1901	1,300	15,600	24,000	[b] 77,674	102,974
1902	2,212	19,048	40,000	[b] 68,363	110,575
1903	1,447	9,782	64,626	[b] 60,605	126,678
1904	1,694	7,225	36,689	[b] 76,815	115,198
1905	3,774	13,250	67,713	[b] 72,612	144,099
1906	5,541	17,974	69,493	[b] 47,590	122,624
1907	10,139	53,600	46,246	[b] 93,262	149,647
1908	3,107	14,810	23,893	[b] 86,404	113,404
1909	2,800	12,300	33,112	69,046	104,958
1910	1,000	15,000	32,098	58,420	91,518
1911	900	9,300	32,255	61,845	95,000
1912	355	2,840	27,767	68,316	96,438
1913	2,300	13,800	69,066	56,430	127,796
1914	.....	.....	41,509	46,153	87,662
1915	1,400	3,300	46,329	29,457	77,186
1916	13,073	52,317	44,934	53,672	111,679
1917	53,955	265,317	58,116	56,589	168,660
1918	75,606	411,850	51,520	37,986	165,112
1919	60,674	343,547	57,166	48,708	166,548
1920	61,111	355,668	38,128	45,264	144,503
1921	76,817	496,394	24,278	33,776	134,871
	390,605	2,292,522	953,986	1,355,730	2,691,321

[a] No figures on imports before 1899 are available.
[b] By fiscal year ending June 30.

The Matanuska coal field is now the center of interest for the development of a coal-mining industry, because it is accessible to the Alaska Railroad. Its high-grade coals are of the same quality as those of Bering River, which is not yet served by a railroad. In their mode of occurrence, with reference to folding and faulting, the coal beds of the two fields are, so far as now known, very similar.

The lower part of the Matanuska field, however, also contains subbituminous coals of about the same quality as the coals of Vancouver Island, British Columbia. It is these subbituminous coals that have now been developed on a commercial scale. They are far less disturbed than the high-grade coals of the upper half of the field and on this account are far cheaper to mine. These high-grade coals have not yet been mined commercially, but they have been extensively explored by the Naval Coal Commission. The local market for the subbituminous coals is constantly increasing, but it is yet to be determined how far they can at present compete, in southeastern Alaska, with the Vancouver Island coals, which lie close to tidewater and are cheaper to mine than those in the Matanuska field.

Though the actual coal reserve of Vancouver Island is estimated to be over 1,000,000,000 tons,[3] the record of mining suggests that

[3] Clapp, C. H., Coal fields of Vancouver Island: Coal Resources of the World, vol. 2, pp. 509–513, Toronto, Canada, 1913.

much of this reserve is not readily available, for there has been no increase in the output of the collieries of Vancouver Island during the last decade, in spite of a growing market for coal. If the Vancouver Island fields are reaching their maximum annual output, the future industrial demands of the Pacific seaboard will force the use of the Alaska coal. Therefore, the possibility of a market for the subbituminous coal of Alaska on the west coast is by no means shut out. The export market for the Alaska high-grade bituminous coal depends on the cost of producing it. Those bituminous coals, because of their higher fuel value, are roughly 25 to 30 per cent more valuable than the subbituminous coals of Alaska and British Columbia. The cost of mining them is greatly increased by the friable condition of the coal beds and walls, the high angle of pitch of the beds, and the gaseous condition of the coal, but above all by the irregularity in occurrence of the beds,[4] which adds to mining costs by the expenditures made for dead work in searching out the coal beds that have been lost by displacements or other irregularities. It is not yet known how much this dead work will add to the cost of the coal mined, but the extra expense may be as much as $4 a ton. It will therefore probably not be safe on present information to estimate the cost of production at less than $10 a ton for the high-grade bituminous coal. Even at such a mining cost, and adding reasonable charges for transportation, there should be an export market for the coal. Of course, there is also a good prospect that systematic development in the Matanuska and Bering River fields will lead to the discovery of areas where the coal is less disturbed than that now developed. If so, a very great reduction in cost is to be expected, but in any event the average cost of recovery for these two coal fields as a whole must be placed at a high figure.

It may therefore be concluded that at present the subbituminous coal of Alaska can be mined and marketed at a profit for local use but can not be marketed at distant ports where it comes into competition with Vancouver Island coal. The high-grade bituminous coal and anthracite of Alaska have not yet been produced for the market. The commercial possibility of their finding an export market will depend on mining costs, as yet unknown. Of their eventual necessity to Pacific coast industries, however, there can be no doubt. It should also be noted that if Alaska becomes a large producer of fuel oil, the market for her coal will be curtailed.

In the Matanuska field[5] coal was mined in 1921 only at the Eska and Evan Jones mines, but considerable coal was recovered incidentally to underground exploration at the two mines of the Naval Coal Commission, at Chickaloon and Coal Creek. Some development

[4] Brooks, A. H., The Alaskan mining industry in 1920: U. S. Geol. Survey Bull. 722, pp. 27–30, 1921.

[5] Information on developments in the Matanuska field furnished by B. W. Dyer, Federal mine inspector.

work was also done on other private leasing units, but no coal was produced.

At the Eska mine productive mining was continued by the Alaskan Engineering Commission until October. During this time 44,630 tons of coal was mined and 3,260 feet of development work was completed. The mine was closed in accordance with a policy of leaving to private initiative the production of coal for the railroad as well as for private use.

The Evan Jones Coal Co., working under a lease, started productive mining in October, when a railroad spur was completed to the mine, in large part at its own expense. Over 3,000 feet of underground work was done.

The Naval Coal Commission completed some 9,605 feet of underground work at the Chickaloon mine and 1,957 feet of underground work and 3,559 feet of diamond drilling at the Coal Creek mine. Incidentally to this work 7,121 tons of high-grade bituminous coal was produced at Chickaloon and 1,337 tons at Coal Creek. The coal washery was completed in 1921 and will be of very material aid to the coal operators of the field. A 5,000-ton sample of coal is to be washed and given a naval test.

The Baxter mine, in the lower, subbituminous part of the field, was reopened late in 1921 and promises to be a coal producer in 1922. Work was started on leasing unit No. 4 by Murphy & Ramson, who drove an entry about 100 feet long and a crosscut about 60 feet long.

No productive mining was done in the Bering River field. The Bering River Coal Co. continued its development work until April, 1921, and later was granted a permit for the suspension of work for one year. A sample of coal is to be taken from this mine for a naval test. Two other leases were granted in the Bering River field during 1921, but no developments were started.

Some 2,500 tons of lignitic coal was mined in the Chulitna-Broad Pass field at three different mines. The facts at hand indicate that there is in this field a large area of coal land adjacent to the railroad. Some high-grade bituminous float coal was found on Riley Creek, but so far as known its source was not discovered.

The Healy River Coal Mining Co. operated its lignite mines in the Nenana field throughout the year. Here a coal bed 8 feet thick without partings is mined from an entry at river level. The coal is hoisted to a tipple on the top of the bluff, which is on the railroad. The Broad Pass Development Co. mined some coal from a shallow opening on Lignite Creek during the winter of 1920–21.

The McNally & Maitland lignite mine, at Bluff Point, Cook Inlet, was operated as usual during the summer. A little lignite was also obtained from the beach near Seldovia. Some lignite was obtained from the Kugruk mine, on Seward Peninsula, from the Bureau of Education mine, at Wainwright Inlet, and from other localities.

PETROLEUM.

No drilling has yet been done on the lands granted by the oil leasing act of 1920, and therefore the Chilkat Oil Co., in the Katalla field, continues to be the only producing oil company in Alaska. This company drilled one well in 1921. Its drilling has all been on one tract of 151 acres, to which patent had been earned before the oil-land withdrawal of 1910. In all 32 holes have been drilled in the Katalla field, of which about 14 found oil and 12 have been made productive. The wells are all small, the maximum daily output, all gained by pumping, being about 25 barrels. On the other hand, some of the wells have produced some oil for nearly 20 years. So far as can be judged from present information, the future of the field will rest on an output from many rather closely spaced shallow wells each with a relatively small production. The facts in hand suggest that a long life for the field is probable. Though no drilling was done in any other field, a number of oil companies had examinations made, and so far as can be learned the reports are satisfactory. The Geological Survey completed the mapping of the Iniskin Bay field and made a reconnaissance of a part of the Cold Bay field. The reports of this work are summarized in a later chapter of this volume, but the conclusions may be summarized as follows:

F. H. Moffit found that the Iniskin Bay region includes a number of long, narrow anticlines which are joined on the seaward side by a great monocline. This monoclinal structure affords a considerable drainage area and may have resulted in the accumulation of pools of oil. S. R. Capps reports that in the Cold Bay district and probably in other parts of the Alaska Peninsula there are structural features favorable to the accumulation of oil and that these are worth drilling and their dimensions suggest the possibility that they may contain large oil pools. In a later section of this report the writer briefly summarizes the geologic information about the possible occurrence of oil pools near Anchorage, where a small seepage was found in 1920.

During 1921 an oil seepage was found on Aniakchak River, about 60 miles southwest of the Cold Bay field. Petroleum is also reported to occur near Chignik, 70 miles southwest of Aniakchak. These discoveries or reported discoveries open up the hope of a much larger area of prospective oil land. The oil seepage at Douglas River, at the base of the Alaska Peninsula, where, so far as known, the geologic conditions are favorable, indicates another possible oil field. The area between the Douglas River and Cold Bay seepages is but little known. Oil seepages have been reported to occur in this unexplored area, which measures about 100 miles from northeast to southwest, but these reports have not been verified. If oil pools are developed at Cold Bay by drilling it is fair to classify much of the region lying

between Chignik and Douglas River as at least promising wildcat territory. This region is about 250 miles long and 5 to 25 miles wide and is unsurveyed. Therefore, it is not known in what percentage of this vast area the structure is favorable. There is no a priori reason for believing that the structural features found in Cold Bay region should not be duplicated in other parts of the peninsula. Clearly, however, the oil resources of this region are entirely unproved and must await drilling. The volcanic region lying near Mount Katmai can not be classed as a favorable field for the oil prospector. The occurrence of oil in the extreme northern part of Alaska, notably near Smith Bay, was further verified in 1921 by examinations made by private individuals. The high cost of surveying this inaccessible region makes it impossible for the Geological Survey to undertake such work under present appropriations. The region is so remote that it is not likely to be developed by private capital under the limitations as to maximum area set by the present leasing law.

Many oil claims were staked and applications for prospecting permits filed in Alaska during the year. A total of 372 permits, aggregating 854,969 acres of land, have been granted. This large acreage includes a very considerable amount of land of which there is no geologic evidence that it is oil bearing—indeed, a part of it can not even be classed as legitimate wildcat territory.

Geographic distribution of lands in Alaska to which oil prospecting permits have been granted.

District.	Number of permits granted.	Total area (acres).	District.	Number of permits granted.	Total area (acres).
Cold Bay	221	517,920	Kachemak Bay	1	2,503
Iliamna	37	94,720	Anchorage	17	35,082
Katalla	41	71,964	Southeastern Alaska	7	17,600
Yakataga	44	110,560			
Seward	4	4,620		372	854,969

Petroleum products shipped to Alaska from other parts of the United States, 1905–1921, in gallons.[a]

Year.	Heavy oils, including crude oil, gas oil, residuum, etc.	Gasoline, including all lighter products of distillation.	Illuminating oil.	Lubricating oil.
1905	2,715,974	713,496	627,391	83,319
1906	2,688,940	580,978	568,033	82,992
1907	9,104,300	636,881	510,145	100,145
1908	11,891,375	939,424	566,598	94,542
1909	14,119,102	746,930	531,727	85,687
1910	19,143,091	788,154	620,972	104,512
1911	20,878,843	1,238,865	423,750	100,141
1912	15,523,555	2,736,739	672,176	154,565
1913	15,682,412	1,735,658	661,656	150,918
1914	18,601,384	2,878,723	731,146	191,876
1915	16,910,012	2,413,962	513,075	271,981
1916	23,555,811	2,844,801	732,369	373,046
1917	23,971,114	3,256,870	750,238	465,693
1918	24,379,566	1,086,852	382,186	362,413
1919	18,784,013	1,007,073	3,515,746	977,703
1920	21,981,569	1,764,302	887,912	412,107
1921	9,209,102	1,403,683	2,021,033	232,784
	269,140,163	26,773,391	14,716,183	4,245,424

[a] Compiled from Monthly Summary of Foreign Commerce of the United States, 1905 to 1921, Bureau of Foreign and Domestic Commerce.

STRUCTURAL MATERIAL, ETC.

The quarrying of marble and mining of gypsum continued in 1921 on about the same scale as in 1920. The Alaska Sulphur Co. completed the building of its reduction plant on Akun Island, in the Aleutian chain, and expected to begin to produce sulphur in 1922.

REVIEW BY DISTRICTS.

The following review, in which the general arrangement is geographic from south to north, summarizes the principal mining developments in all the districts, so far as the facts about them are available. With the present reduced technical force of the Alaskan branch of the Geological Survey but few of the districts could be visited by a geologist during the year 1921. This fact and the failure of some of the mine operators to make reports leaves a dearth of information about some of the districts, especially those of the Kuskokwim region. The space here devoted to any district is therefore not necessarily a measure of its relative importance.

SOUTHEASTERN ALASKA.

The mineral output of southeastern Alaska in 1921 was derived from 10 gold and silver lode mines, 1 copper mine, a few small placer operations, a gypsum mine, and a group of large marble quarries. The total value of the mineral output decreased from $5,120,163 in 1920 to $3,865,150 in 1921. This decrease is due to the decline in output from the large gold mines at Juneau and the suspension of operations at the Salt Chuck palladium mine, in the Ketchikan district. In spite of the decline of output, there was a marked advance in the development of gold and silver bearing lodes, notably in the Portland Canal and Sitka districts.

KETCHIKAN DISTRICT.

The Rush & Brown copper mine was operated in 1921, as it has been for many years. Underground developments on the ore body are reported to have now reached a depth of 500 feet, and six levels have been opened. Operations at the Salt Chuck mine were suspended at the end of 1920. Productive mining was continued during 1921 at the Julia mine, owned by the Kasaan Gold Mining Co. The Chomley Mining Co. did some underground work at the Moonshine silver-lead prospect, on Prince of Wales Island. Except for assessment work, no other important mining development work was done in the district immediately tributary to Ketchikan.

More notable advances were made in lode mining in the region tributary to Hyder, at the head of Portland Canal.[6] The continued

[6] Westgate, L. G., Ore deposits of the Salmon River district, Portland Canal region, Alaska: U. S. Geol. Survey Bull. 722, pp. 117–140, 1921.

success of the Premier mine, lying on the Canadian side but close to the international boundary, has stimulated lode-mining development in the Alaska part of the district. In 1921 the Premier produced 4,356 tons of ore, "yielding 35,000 ounces of gold and 1,200,000 ounces of silver, valued at $1,400,000." [7]

The principal developments near Hyder were those made on the property of the Fish Creek Mining Co., from which some silver-lead ore carrying both gold and copper was shipped. This mine has been developed by adits and crosscuts, the work of some 10 to 15 men from June to the end of the year. Considerable underground work was also done in the same district on the New Alaska group, on the Hoveland property, and the Riverside and Lucky Bay groups, and a discovery was made on the Fitzgerald claim.[8]

Nothing but development work was done on the molybdenite deposits near Shakan, near the north end of Prince of Wales Island. Near by the quarries of the Vermont Marble Co. were as usual operated for about nine months in the year and employed from 40 to 50 men.

WRANGELL DISTRICT.

In 1920 the Northern Copper Co. purchased the copper claims of the Kupreanof Mining Co., on Kupreanof Island, in the Wrangell district. Development work, which began in 1920, was continued in 1921 and consisted of the opening of a 100-foot adit and a 500-foot open cut, besides considerable stripping and the digging of numerous pits. Assessment work only was done on other properties in the Wrangell district.

JUNEAU DISTRICT.

The Ready Bullion and Alaska Juneau mines were operated throughout the year. The Perseverance, owned by Alaska Gastineau Mining Co., was operated only until July 1, when the plant was dismantled and the mine abandoned, because, as the management reports, the "ore is entirely too low grade to mine at a profit." The value of the total metal contents of ore mined on this property in 1921 averaged 80 cents to the ton. Productive work was continued on a small scale at the Peterson mine, north of Juneau, and at the Daisy Bell, on Snettisham Inlet. Developments were continued at the Alaska Peerless mine, on Windham Bay, and the owners report that the mine will be on a productive basis in 1922. B. D. Stewart reports the discovery in 1921 of a silver-lead ore body carrying zinc on Howard Bay, on the west side of Lynn Canal, on which considerable development work was done.

[7] Robertson, W. F., Minister of Mines Ann. Rept. for 1921, p. G 71, Victoria, B. C., 1922.

[8] Idem, pp. G 71-72. Stewart, B. D., and Dyer, B. W., Territorial Mine Inspector Ann. Rept. for 1920, Juneau, 1922.

The Alaska Endicott Mining & Milling Co. continued work on its property near William Henry Bay. About 1,800 feet of underground work has been done, and the installation of a mill started.

A 25-foot shaft and 150-foot adit were excavated and considerable open-cut work was done at the Pekovich mine, on Funter Bay, Admiralty Island. Progress was also made in the installation of surface equipment. Some ore was mined and treated at the 10-stamp mill. The Alaska Dano Mines Co. (Nowell Otteson) continued development work on its claims on Funter Bay.

SITKA DISTRICT.

The Chichagof is still the only producing mine in the Sitka district and is one of the four largest gold mines in Alaska. In 1921 the main inclined shaft was sunk 142 feet, giving a total depth of 1,250 feet. The horizontal workings of the mine now aggregate 26,650 feet in length. Five stamps were added to the mill in 1921, making 25 in all. Mine and mill were operated throughout the year.

The Hirst Chichagof property, near by, has been developed by an 1,800-foot adit and a 200-foot raise. A 10-stamp mill is being erected on the property. A little work was also done at the Jumbo claim, owned by Louis A. Smith. Here a little ore was run through a half-ton test mill, which is on the property. The underground work consists of a 50-foot shaft, a 35-foot drift, and a 45-foot adit. The El Nido group of claims, near Lisianski Inlet,[9] has been developed by an adit 593 feet long and by crosscuts. A part of this work was done in 1921. Work was also continued on a parallel vein of gold quartz in the Apex group. B. D. Stewart reports that some developments were also made on the Brown Bear group of gold claims, near Deep and Diedrickson bays of Portlock Harbor, on the west side of Chichagof Island. According to Stewart, the quartz vein is 12 to 40 inches wide, averages about 2 feet in width on the outcrop, and has been opened for several hundred feet on the surface. Stewart also reports a pyrrhotite deposit, said to carry nickel, on Yakobi Island. Assessment work was done on a number of other gold quartz veins in the district.

The Pacific Coast Gypsum Co. operated its gypsum mine near Iyoukeen Cove, on Chichagof Island. The workings now reach a depth of 300 feet. About 25 men are employed.

MISCELLANEOUS LOCALITIES.

No gold placer mining was done in the Porcupine district during 1921. Some copper ore was shipped through the district from the Rainey Hollow region, an adjacent part of Canada. Assess-

[9] Brooks, A. H., The Alaskan mining industry in 1920: U. S. Geol. Survey Bull. 722, pp. 37–38, 1921.

ment work was done on placer claims in the Lituya Bay district, and four or five men did some beach mining at Lituya Bay and Yakutat.

COPPER RIVER BASIN.

The continuous operation of the three large copper mines of the Kennecott group and the summer placer mining in the Nizina and Chistochina districts constitute all the productive work done in the Copper River basin in 1921. The only other lode operations were assessment work on copper and gold claims.

The following statements on mining and milling at the Kennecott group of mines during 1921 are taken from the annual report of the company:[10]

Kennecott ores milled totaled 212,723 tons, assaying 5.62 per cent copper. From this tonnage there resulted 18,571.4 tons of concentrates, assaying 49.01 per cent copper. The recovery in the mill was 77.82 per cent, as compared to 82.29 per cent in 1920. This decrease in recovery was largely due to a more careful preliminary sorting of high grade from milling ores and to the generally lower grade of ore treated during the year. This applied particularly to the ores from the Glacier mine, it being thought advisable to treat a larger tonnage from this source while the copper market did not warrant the usual copper production. The cost of milling was 71.9 cents per ton, compared to 76 cents in 1920.

The leaching plant at Kennecott was operated but eleven months during the year, a shutdown being necessitated by a remodeling of the piping system. There were treated 192,551 tons of mill tailings, assaying 0.95 per cent carbonate copper, with recovery of 2,808,000 pounds copper in the form of precipitates assaying 74.63 per cent. The leaching recovery was 76.56 per cent, compared to 74.5 per cent in 1920.

The fact that the leaching plant did not operate continuously, added to the lower milling recovery above mentioned, reduced the total extraction on milling ores to 86.07 per cent, as against 90.10 per cent in 1920.

A total of 17,647 feet of development was done, 11,483 feet of this being at the Kennecott properties and 6,164 feet at Latouche. In addition, 8,343 feet of diamond drilling was done, all at Kennecott.

Even of more importance than the very favorable development of the Bonanza-Mother Lode vein in Bonanza ground was the discovery of a new ore body to the southeast of the main workings on the 700 level at the Jumbo mine.

Aside from the operations recorded above and those at the Mother Lode mine, there were no important developments of copper properties in the Chitina district. It is reported that a rich ore shoot was uncovered on the Green group of claims on McCarty Creek.

Hydraulic mining continued on a large scale in the Nizina placer district. Three hydraulic mines were operated for about 100 days during the summer, and some drift mining was done on bench placers. About 100 men were employed in this work. Practically the only placer mining in the Chistochina district was that of a hydraulic plant on Slate Creek, employing about 25 men. The value of the total placer gold output of the Copper River basin in 1921 was $220,000.

[10] Kennecott Copper Corporation Seventh Ann. Rept., for 1921, p. 6, New York, 1922.

PRINCE WILLIAM SOUND.

In 1921 the only important mining on Prince William Sound was done at the Beatson copper mine, on Latouche Island. Here operations were continued throughout the year, but, on account of the low price of copper, on a reduced scale compared with previous years. A total of 6,164 feet of underground development work was done at Latouche. The following statement is taken from the report of the Kennecott Copper Corporation:[11]

> The Latouche property was operated at 50 per cent capacity until April 1 and at approximately one-fourth capacity during the remainder of the year. A total of 168,108 tons of ore, assaying 1.83 per cent copper, were milled, with a resultant production of 17,207 tons concentrates assaying 15.33 per cent copper. The recovery was 85.92 per cent, as compared to 82.85 per cent for the previous year.

At Rua Cove, on Knight Island, W. A. Dickey continued driving a drift, now 60 feet in length, with several crosscuts at a depth of 800 feet below the highest outcrop of the ore body. No work was done at Girdwood, on Latouche Island; at the Fidalgo, on Fidalgo Bay; at the Midas mine, near Valdez; or at the Threeman mine, on Landlocked Bay.

A little gold ore was milled from three small mines in the Valdez district—that of the Valdez Gold Co., where 400 feet of underground work was done; the Tuscarora, where about 110 feet was done; and the Big Four, where about 450 feet was done. The many gold and copper claims of Prince William Sound on which a little assessment work was done during 1921 are too numerous to list here.

KENAI PENINSULA.

About eight placer mines were operated on Kenai Peninsula and in the adjacent region in 1921. These employed about 30 men and produced gold to a total value of about $25,000. The largest operations were on Crow Creek, north of Turnagain Arm, where a hydraulic plant was operated. Some advance was made on several other hydraulic installations on Kenai Peninsula.

At the Lucky Strike mine, in the Hope district, about 300 feet of adit was driven. On account of an accident, the mill was operated only for about six weeks. Work was continued at the Strong mine, at Mile 89, and some ore was shipped. These were the only two lode mines in the region that were productive in 1921. Work at the Jewel mine, in Crow Creek Pass, consisted of the installation of a 10-stamp mill, water power, and tram. Though no large lode developments were made in the Kenai Peninsula region during 1921, there was much prospecting of auriferous quartz veins. The only other mining on the peninsula was the operation of the McNally & Maitland lignitic coal mine, on Kachemak Bay (p. 17).

[11] Kennecott Copper Corporation Seventh Ann. Rept., for 1921, p. 6, New York, 1922.

SUSITNA-MATANUSKA REGION.

Productive mining in the Susitna-Matanuska region included gold placer mining in the Yentna district and at a few scattered localities, gold-lode mining in the Willow Creek district, bituminous-coal mining in the Matanuska field, and a little lignite mining at a number of scattered localities in the Susitna basin. (See p. 17.) The value of the total mineral production from this region was $324,810 in 1920 and $677,025 in 1921. The completion of the Alaska Railroad has made this region relatively accessible, and hence the search for mineral deposits has been greatly stimulated. The finding of a small oil seepage near Anchorage (p. 18) has raised the hope that petroleum may occur in the lower Matanuska and Susitna regions.

WILLOW CREEK DISTRICT.

Productive gold mining was done on seven lode mines in the Willow Creek district. The largest output came from the Gold Bullion and Lucky Shot mines, controlled by the Willow Creek Mining Co. Considerable development work was also done at the Kelly Gold Mint and Mabel mines, as well as on a number of prospects that have not yet been productive. The systematic underground exploration of the lodes in the Willow Creek district seems now assured, as certain small properties have been consolidated.

In the past the gold has come from small mines, many of which are equipped with mills more remarkable for their novelty than for their efficiency. The lodes of the district occur in well-defined fissures traversing dioritic rocks. Most of them are remarkably persistent, though some are faulted. Within these lodes are rich ore shoots, and mining has been limited to the search for and extraction of the ore from these shoots. In general the lodes have not been systematically developed to block out an ore tonnage, owing to lack of technical knowledge and of sufficient capital. As a consequence most of the mines are being worked on a hand-to-mouth basis. Plans have been formulated for larger-scale operations and above all for more systematic exploration of ore bodies. The surface indications more than warrant the careful underground exploration of the lodes already discovered.

Gold and silver produced at lode mines in the Willow Creek district, 1908–1921.

Year.	Mines operated.	Ore mined (short tons).	Gold.		Silver.	
			Ounces.	Value.	Ounces.	Value.
1908	1	12	87.08	$1,800	6.88	$3.64
1909	1	140	1,015.87	21,000	80.25	41.73
1910	1	144	1,320.15	21,290	104.29	56.31
1911	2	812	2,505.82	51,800	197.95	109.91
1912	3	3,000	4,673.02	96,600	369.07	226.97
1913	3	3,028	4,883.94	100,960	385.83	233.42
1914	3	10,110	14,376.28	297,184	1,330.00	735.00
1915	3	6,117	11,961.55	247,267	811.00	421.00
1916	3	12,182	14,473.46	299,193	1,468.00	967.00
1917	5	7,885	9,466.17	195,662	713.00	586.00
1918	5	13,043	13,043.05	269,624	724.00	724.00
1919	5	6,730	7,882.00	162,944	508.00	509.00
1920	3	2,850	3,067.00	63,400	148.00	158.00
1921	7	3,591	5,721.50	118,273	1,029.00	1,029.00
		69,644	94,476.89	1,946,997	7,875.27	5,800.98

YENTNA DISTRICT.

The most important event of the year in the Yentna district was the resumption of operations by the dredge on Cache Creek, which had been closed down pending the installation of a hydroelectric power plant. This plant was completed in 1920, and the dredge had a successful season in 1921. Twenty-four placer mines, employing 85 men, were operated in the Yentna district in 1921 and produced $120,000 worth of gold. There is a notable increase in the use of hydraulic methods in the district, 12 hydraulic plants being operated in 1921. As a consequence of the use of hydraulic and dredging methods, about 270,000 cubic yards of gravel was mined in the district during the year, with an average gold recovery of 44 cents to the cubic yard.

BROAD PASS AND TALKEETNA REGION.

Since the completion of the railroad through Broad Pass there has been renewed activity in the prospecting of copper and gold lode deposits in the tributary regions, but details are lacking. A little placer mining has also been done in this region. Considerable evidence has been found that there is a large lignite-bearing area in the upper Chulitna basin. Much of the coal is covered by bench gravels, but in many places this covering is not so thick as to preclude the economic exploitation of the underlying coal.

VALDEZ CREEK DISTRICT.

Valdez Creek is an eastern tributary of the upper Susitna River, about 60 miles by trail from the Alaska Railroad. Placer gold was discovered on this creek in 1903, and since then some mining has been done on it each year. The richest gravels occur as bench

deposits, which are well located for hydraulic mining. A hydraulic plant has been installed and is engaged in exploiting these high gravels. So far as known, only one other placer mine was operated in this district in 1921.

SOUTHWESTERN ALASKA.

The most important event of the year in southwestern Alaska, including the Iliamna region, was the staking of oil claims, already noted (p. 18). In the Lake Iliamna region the prospecting of copper and gold bearing lodes was continued. At the Duryea copper claim some development work was done, and plans are under way to send out a test shipment of ore.

A few men were engaged in beach placer mining at the south end of Kodiak Island, and a little work was done on auriferous veins on the island. Progress at the sulphur mine on Akun Island has already been noted (p. 20).

YUKON BASIN.

The value of the total mineral output of the Alaska Yukon region was $2,093,088 in 1921, as compared with $2,329,286 in 1920. This brings the total value of the mineral products of the Alaska Yukon during 36 years of mining to $135,276,843.

Mineral production of the Yukon basin, Alaska, in 1921.

	Placer mines.		Lode mines.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	89,977	$1,860,000	1,941	$40,130	91,918	$1,900,130
Silver.....do....	11,952	11,952	88,379	88,379	100,331	100,331
Coal.....tons..	.....	.....	.....	.....	14,584	65,932
Lead, copper, and tin.....	.....	.....	.....	.....	.....	26,695
	.....	1,871,952	.....	128,509	.....	2,093,088

Mineral production of the Yukon basin, Alaska, 1886–1921.

	Placer mines.		Lode mines.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Gold.....fine ounces..	6,395,835	$132,212,000	62,799	$1,297,675	6,458,634	$133,509,675
Silver.....do....	1,095,399	668,342	237,791	239,717	1,333,190	908,059
Coal.....tons..	.....	.....	.....	.....	57,435	319,553
Lead, copper, tin, antimony, tungsten, and platinum.....	.....	.....	.....	.....	.....	539,556
	.....	132,880,342	.....	1,537,392	.....	135,276,843

In the summer of 1921 about 335 placer mines, employing 1,130 men, were operated in the Alaska Yukon, and during the previous winter about 80 mines, employing 335 men. The only other productive mining in this region in 1921 was done at eight lode mines, employing about 40 men, and two coal mines, employing about 25 men. None of these mines were operated throughout the year.

Estimated value of gold produced from principal placers of Yukon basin in 1921.

Fairbanks	$570,000	Circle	$60,000
Iditarod	350,000	Fortymile	50,000
Tolovana	285,000	Hot Springs	35,000
Ruby	170,000	All others	122,000
Innoko and Tolstoi	110,000		
Koyukuk	78,000		1,860,000

FAIRBANKS DISTRICT.

Placer and lode mining was continued at Fairbanks on about the same scale as in 1920. The value of the total mineral output of the district during 19 years of mining is $73,263,401. Some antimony, tungsten, and lead have been produced in the Fairbanks district, but, as shown in the following table, the mineral output has come chiefly from the placer mines.

Placer gold and silver produced in the Fairbanks district, 1903–1921.

Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.
1903	1,935.00	$40,000	348	$188
1904	29,025.00	600,000	5,225	2,821
1905	290,250.00	6,000,000	52,245	28,212
1906	435,375.00	9,000,000	78,367	42,318
1907	387,000.00	8,000,000	69,660	37,616
1908	445,050.00	9,200,000	79,909	43,151
1909	466,818.75	9,650,000	84,027	45,375
1910	295,087.50	6,100,000	53,116	28,683
1911	217,687.50	4,500,000	52,245	27,690
1912	200,756.25	4,150,000	48,182	29,632
1913	159,637.50	3,300,000	20,274	12,245
1914	120,937.50	2,500,000	29,024	16,050
1915	118,518.75	2,450,000	28,444	14,421
1916	87,075.00	1,800,000	11,058	7,276
1917	63,371.25	1,310,000	8,379	6,904
1918	38,700.00	800,000	5,708	5,708
1919	35,313.75	730,000	5,197	5,820
1920	28,057.50	580,000	3,870	4,218
1921	27,573.75	570 000	3,941	3,941
	3,448,170.00	71,280,000	639,219	362,270

The placer output of 1921 came from 48 placer mines, employing 340 men, in the summer and 14 mines, employing 107 men, during the previous winter. During 1920 work was done at 45 summer mines, employing 345 men, and 9 winter mines, employing 54 men. About 425,000 cubic yards of gravel was sluiced in 1921, having an average gold content of about $1.34 to the cubic yard. The placer

mines comprised 28 drift mines, of which 13 were operated in the winter as well as in the summer and 1 only in winter, 2 dredges, 9 open-cut mines using steam scrapers, 4 hydraulic mines, and 6 small open-cut mines without any special mechanical equipment. The drift mines sluiced about 52,000 cubic yards of gravel carrying $4.75 worth of gold to the cubic yard. Some 372,000 cubic yards of gravel were sluiced from the open-cut mines and the dredges. The gold recovery from this gravel was about 85 cents to the cubic yard. The sluicing season averaged about 130 days.

The largest single drift-mining operation was on Dome Creek, and the two dredges on Fairbanks Creek were the largest open-cut plants. On Cleary Creek, formerly the largest producer of placer gold, only half a dozen mines, most of them small, were in operation in 1921. Plans for dredging on Cleary Creek, long under consideration, appear to have not yet taken definite form. Seventeen placer mines, large and small, were operated in the Goldstream Creek basin in 1921. The extensive dredging ground on Cleary and Goldstream creeks is well worth careful examination. The only new placer discovery near Fairbanks in 1921 was made on Kokomo Creek, a southerly tributary of the Chatanika. This find seems in itself to be of no very great importance, but it indicates that the auriferous belt extends 10 miles farther east than had previously been known. The lowering of mining costs near Fairbanks which will be brought about by the Alaska Railroad and the making available of the lignitic coal from the Nenana field will undoubtedly soon lead to a renewal of placer mining in the Fairbanks district.

Approximate distribution of placer gold produced in Fairbanks district, 1903–1921.

Cleary Creek and tributaries	$23,142,000
Goldstream Creek and tributaries	14,836,000
Ester and adjacent creeks	11,394,000
Dome and Fairbanks creeks	16,236,000
Vault Creek and tributaries	2,673,000
Little Eldorado Creek	2,302,000
All other creeks	697,000
	71,280,000

The railroad and the availability of the Nenana coal will also greatly stimulate lode mining at Fairbanks. No large auriferous lodes have been developed in the district, but the fact that a number of small ones have been profitably exploited in spite of the high cost of supplies and fuel is an indication of the latent possibilities of the gold-quartz veins of the district. The average recovery from the gold ores mined during the last 12 years is $35 a ton, and at many of the mines little or no profit was made. Under present conditions

ores of lesser value can no doubt be profitably mined. Nearly all the lode deposits of the Fairbanks district are readily accessible to good wagon roads, and some are only a few miles from the railroad.

During 1921 underground work was continued at a number of small quartz mines in the Fairbanks district. At the Billy Sunday the principal developments were drifting on the 120-foot level, stoping, and the sinking of a new shaft to a depth of 80 feet. The ore was treated at a mill on a property near by. At the Crites & Feldman Hi Yu mine the principal work was the continuation of an adit. The ore was treated in a mill on the property. On the Wyoming the main adit, 300 feet long, was extended, and a 60-foot winze was installed. The ore was treated at the near-by Rhoads & Hall mill. Some ore was mined by open-cut on the Discovery mine, on Bedrock Creek, and on its tributaries. This ore also was treated at the Rhoads & Hall mill. The above-named four were the only producing quartz mines in the district, but development was continued at some other lode properties.

Lode gold and silver produced in the Fairbanks district, 1910–1921.

Year.	Crude ore (short tons).	Gold.		Silver.	
		Fine ounces.	Value.	Fine ounces.	Value.
1910	148	841.19	$17,389	106	$57
1911	875	3,103.02	64,145	582	308
1912	4,708	9,416.54	394,657	1,578	971
1913	12,237	16,904.98	349,457	4,124	2,491
1914	6,526	10,904.75	225,421	2,209	1,222
1915	5,845	10,534.91	217,776	1,796	910
1916	1,111	1,904.81	39,376	140	92
1917	1,200	2,311.38	47,781	2,217	1,826
1918	1,035	1,294.04	26,750	616	656
1919	1,384	2,026.57	41,893	378	424
1920	504	967.48	20,000	164	178
1921	944	1,858.27	38,414	279	279
	36,517	62,067.94	1,283,059	14,189	9,374

HOT SPRINGS DISTRICT.

As seen by the subjoined table, gold placer mining has for several years been on the decline in the Hot Springs district. There are still large reserves of placer gold in the district, but the high cost of operation has of late not encouraged work. Eighteen placer mines, employing 40 men, were operated in the district during the summer of 1921, and five, employing eight men, during the previous winter. That the mining was done only on a small scale is shown both by the number of men employed and by the fact that only six of these mines produced more than $1,000 worth of gold each. Most of the gold produced in the district has come from drift mining, but this form of operation has very much declined. The shallower placers exploited by open cuts, with some hydraulicking, are now increasing.

Placer gold and silver produced in the Hot Springs district, 1902–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1902–3	12,717.79	$262,900	1,818	$964	1914	36,281.25	$750,000	6,125	$3,387
1904	7,038.56	145,500	1,007	584	1915	29,508.75	610,000	4,982	2,526
1905	5,805.00	120,000	831	507	1916	38,700.00	800,000	6,534	4,299
1906	8,707.50	180,000	1,245	843	1917	21,768.75	450,000	3,675	3,028
1907	8,465.63	175,000	1,210	798	1918	7,256.25	150,000	1,225	1,225
1908	7,256.25	150,000	1,038	550	1919	4,837.50	100,000	817	915
1909	15,721.88	325,000	2,248	1,169	1920	2,418.75	50,000	567	618
1910	15,721.88	325,000	2,248	1,169	1921	1,693.12	35,000	438	438
1911	37,974.37	785,000	5,430	2,932					
1912	19,350.00	400,000	3,267	2,009		300,573.23	6,213,400	47,972	29,934
1913	19,350.00	400,000	3,267	1,973					

TOLOVANA DISTRICT.

In the Tolovana district 32 summer mines, employing about 120 men, and 15 winter mines, employing 70 men, were operated in 1921. The output of gold, as shown in the subjoined table, was larger than in 1920, but this statement is somewhat misleading, for the gold was in part derived from the sluicing of gravels resulting from deep mining during the previous two years, when there had not been water enough to clean up the winter dumps. During the later half of the summer of 1921 there was a considerable rainfall, and as a consequence a number of hydraulic plants were operated on the small creeks of the district. The reports from six of the larger of these plants show gold recoveries exceeding $1 to the cubic yard. The drift mines, principally those on Livengood Creek, are by far the chief source of the Tolovana gold; their gold output in 1921, including that derived from the sluicing of gravels mined in previous years, had a value of about $235,000. The returns from seven of these drift mines were complete enough to determine that on the average they recovered about $6.50 worth of gold to the cubic yard of gravel sluiced.

Late in the summer of 1921 a discovery of placer gold was made on Wilbur Creek, a tributary to Tolovana River from the south, about 7 miles from the mouth of Livengood Creek. As yet this placer has proved of no great size, but it may be important by indicating a second zone of mineralization south of the Tolovana similar to the one north of the river from which the Livengood and associated placers derive their gold.

Placer gold and silver produced in the Tolovana district, 1915–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1915	3,870.00	$80,000	321	$163	1920	9,675.00	$200,000	819	$893
1916	33,862.50	700,000	2,813	1,851	1921	13,786.88	285,000	1,189	1,189
1917	55,631.25	1,150,000	8,430	6,946					
1918	42,328.12	875,000	4,060	4,060		184,550.63	3,815,000	19,773	17,556
1919	25,396.88	525,000	2,141	2,454					

RAMPART DISTRICT.

During 1921 mining was continued in a small way in the Rampart district. A total of nine summer placer mines, employing 20 men, and one winter mine, employing three men, were worked. The largest production came from Hunter and Little Minook creeks. According to the return made, the average gold recovery was about $2.15 to the cubic yard. It is reported that a dredge is to be installed on Minook Creek.

Placer gold and silver produced in the Rampart district, 1896–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1896–1903	29,799.00	$616,000	4,440	$2,664	1914	1,451.25	$30,000	257	$142
1904	4,353.75	90,000	649	376	1915	1,693.13	35,000	300	152
1905	3,870.00	80,000	576	351	1916	1,935.00	40,000	343	226
1906	5,805.00	120,000	865	588	1917	1,596.37	33,000	280	231
1907	6,046.87	125,000	901	595	1918	1,161.00	24,000	206	206
1908	3,628.12	75,000	540	286	1919	1,451.25	30,000	90	101
1909	4,837.50	100,000	721	375	1920	967.50	20,000	69	75
1910	2,080.12	43,000	310	167	1921	967.50	20,000	68	68
1911	1,548.00	32,000	231	125		76,287.36	1,577,000	11,394	7,062
1912	1,548.00	32,000	274	169					
1913	1,548.00	32,000	274	165					

CIRCLE DISTRICT.

In the Circle district 21 summer mines, employing 41 men, and 7 winter mines, employing 12 men, were operated in 1921. The dredge on Mastodon Creek was the largest single plant in operation. It ran for 80 days. Most of the other operations were very small, except for a hydraulic plant on Eagle Creek. The average gold recovery from the open-cut mines of the district was about 45 cents to the cubic yard.

Placer gold and silver produced in the Circle district, 1894–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1894	483.75	$10,000	123	$77	1909	10,884.37	$225,000	2,830	$1,472
1895	7,256.25	150,000	1,886	1,226	1910	10,884.37	225,000	2,830	1,523
1896	33,862.50	700,000	8,794	6,080	1911	16,931.25	350,000	4,402	2,333
1897	24,187.50	500,000	6,289	3,773	1912	15,721.87	325,000	2,439	1,500
1898	19,350.00	400,000	5,031	2,968	1913	8,465.63	175,000	1,314	794
1899	12,093.75	250,000	3,144	1,886	1914	10,884.37	225,000	1,689	934
1900	12,093.75	250,000	3,144	1,886	1915	11,126.25	230,000	1,727	875
1901	9,675.00	200,000	2,512	1,507	1916	14,512.50	300,000	2,252	1,482
1902	9,675.00	200,000	2,512	1,331	1917	9,675.00	200,000	1,561	1,285
1903	9,675.00	200,000	3,144	1,698	1918	8,465.63	175,000	1,798	1,798
1904	9,675.00	200,000	3,144	1,823	1919	6,530.63	135,000	1,260	1,411
1905	9,675.00	200,000	3,144	1,918	1920	2,660.62	55,000	464	506
1906	14,512.50	300,000	3,773	2,565	1921	2,902.50	60,000	571	571
1907	9,675.00	200,000	3,144	2,075					
1908	8,465.63	175,000	2,212	1,166		320,000.62	6,615,000	77,133	48,468

RICHARDSON DISTRICT.

No extensive placer ground has yet been opened in the Richardson district, and most of the gold produced is obtained incidentally in prospecting. In 1921 reports of production were received from only four mines in this district, on Caribou, Democrat, and Tenderfoot creeks and Chena River, but there were probably other small producers. B. E. Shuff has done some open-cut work on the Democrat lode, on Democrat Creek, and reports it to be of high tenor in gold.

Placer gold and silver produced in the Richardson district, 1905–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1905.....	(a)	(a)	(a)	(a)	1915.....	4,595.62	$95,000	939	$476
1906.....	4,837.50	$100,000	989	$673	1916.....	3,870.00	80,000	790	520
1907.....	18,140.62	375,000	3,707	2,447	1917.....	1,289.37	25,000	245	202
1908.....	18,140.62	375,000	3,707	1,965	1918.....	290.25	6,000	59	59
1909.....	7,256.25	150,000	1,483	771	1919.....	483.75	10,000	99	111
1910.....	4,837.50	100,000	989	534	1920.....	338.62	7,000	69	75
1911.....	4,837.50	100,000	989	524	1921.....	145.13	3,000	26	26
1912.....	4,837.50	100,000	989	608					
1913.....	4,837.50	100,000	989	597		83,875.23	1,726,000	17,058	10,135
1914.....	4,837.50	100,000	989	547					

a Prospects.

EAGLE DISTRICT.

In the Eagle district 12 open-cut mines, employing 26 men, were operated in 1921. The largest operations were those of hydraulic plants on Alder and Crooked creeks.

Placer gold and silver produced in the Eagle and Seventymile districts, 1908–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1908.....	483.75	$10,000	76	$40	1916.....	822.37	$17,000	130	$86
1909.....	1,209.37	25,000	191	99	1917.....	628.88	13,000	96	75
1910.....	483.75	10,000	76	41	1918.....	1,209.37	25,000	191	191
1911.....	580.50	12,000	92	49	1919.....	969.50	20,000	152	170
1912.....	967.50	20,000	164	100	1920.....	725.62	15,000	99	108
1913.....	2,418.75	50,000	382	231	1921.....	774.00	16,000	93	93
1914.....	2,418.75	50,000	382	211					
1915.....	1,935.00	40,000	305	155		15,627.11	323,000	2,429	1,649

FORTYMILE DISTRICT.

In the Fortymile district 52 summer mines, large and small, employing 100 men, and 12 winter mines, employing 15 men, were worked during 1921. This large number of mines is misleading, for most of them were very small. Indeed, there were only 11 mines

whose individual gold output exceeded $1,000. These 11 employed 40 men and produced $30,000. The average value of the gold content of the gravel sluiced by these mines was about $1.10. They were operated from 130 to 180 days during the summer. The most successful mining was done on Dome Creek, where a large hydraulic plant was operated. This plant is owned by the Dome Creek Gold Corporation, which reports that it is planning for still larger operations. This is the first attempt to mine bench placers on a large scale. As deposits of this type are common in the Fortymile district, the success of the Dome Creek plant will undoubtedly lead to further development of the bench gravels. It is worthy of note that this and several other smaller hydraulic plants were operated successfully in 1921, in spite of the fact that the rainfall appears to have been below normal.

Except for the plants noted above, the rest of the mining consisted chiefly of grubstake work. Indeed, about 20 of the "mines" represent nothing more than individuals working on the bars of Fortymile River, most of them for not over a month of the summer.

Placer gold and silver produced in the Fortymile district, 1886–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1886–1903	193,500.00	$4,000,000	30,553	$22,915	1914	2,418.75	$50,000	382	$211
1904	14,851.12	307,000	2,345	1,360	1915	2,418.75	50,000	382	194
1905	12,384.00	256,000	1,955	1,193	1916	2,418.75	50,000	382	251
1906	9,868.50	204,000	1,558	1,059	1917	3,870.00	80,000	624	513
1907	6,772.50	140,000	1,069	706	1918	3,628.12	75,000	573	573
1908	6,772.50	140,000	1,069	567	1919	1,983.37	41,000	313	350
1909	10,884.37	225,000	1,719	894	1920	1,935.00	40,000	348	380
1910	9,675.00	200,000	1,528	825	1921	2,418.75	50,000	448	448
1911	9,675.00	200,000	1,528	810					
1912	10,303.87	213,000	1,627	1,000		310,615.85	6,421,000	49,167	34,710
1913	4,837.50	100,000	764	461					

CHISANA DISTRICT.

In the Chisana district six mines, employing 16 men, were operated during the summer of 1921. The average gold recovery was about $1.45 to the cubic yard. The mining consists chiefly in removing the overburden by booming—that is, by the use of automatic dams. Later the gold-bearing gravels are shoveled into sluice boxes. Mining starts with the spring break-up in May and is generally uninterrupted until July, after which there are likely to be periodic shortages of water.

Placer gold and silver produced in the Chisana district, 1913–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1913.....	1,935.00	$40,000	465	$280	1919.....	1,306.12	$27,000	314	$352
1914.....	12,093.75	250,000	2,910	1,609	1920.....	967.50	20,000	137	150
1915.....	7,740.00	160,000	1,862	944	1921.....	1,112.62	23,000	164	164
1916.....	1,935.00	40,000	465	306					
1917.....	1,935.00	40,000	420	346		29,750.62	615,000	6,897	4,311
1918.....	725.63	15,000	160	160					

BONNIFIELD DISTRICT.

The Bonnifield placer district is in general coextensive with the Nenana coal field. No rich placers have been found in this district, but placer mining in a small way has been going on for the last 19 years. Some auriferous lodes have also been found in the district. The coal-mining operations in the region have been described on page 17. There are in the district some very extensive sheets of gravel that carry gold prospects, but they have not been tested sufficiently to determine whether they form commercial gold placers. In general the physical conditions favor hydraulic mining, and now that the region is accessible by rail a careful examination of its low-grade placers is justified. In 1921 eight open-cut mines, employing 16 men, were operated in the Bonnifield district. The largest operations were on Grubstake, Moose, Eva, and Daniels creeks. The mining season is reported to be from 115 to 180 days in length, and the gravels sluiced carried less than $1 to the cubic yard.

Placer gold and silver produced in the Bonnifield district, 1903–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1903–1906.	1,451.25	$30,000	227	$136	1915.....	967.50	$20,000	152	$77
1907.....	241.87	5,000	38	25	1916.....	483.75	10,000	76	50
1908.....	241.87	5,000	38	20	1917.....	580.50	12,000	98	81
1909.....	2,418.75	50,000	379	197	1918.....	580.50	12,000	91	91
1910.....	483.75	10,000	76	41	1919.....	483.75	10,000	75	84
1911.....	967.50	20,000	152	81	1920.....	241.87	5,000	38	41
1912.....	967.50	20,000	152	93	1921.....	774.00	16,000	114	114
1913.....	967.50	20,000	152	92					
1914.....	1,451.25	30,000	227	126		13,303.11	275,000	2,085	1,349

KANTISHNA DISTRICT.

The Kantishna district,[12] just north of Mount McKinley, has long been the scene of a little placer mining, as well as of small developments of gold and silver-bearing lodes. Two years ago a galena

[12] Capps, S. R., The Kantishna district, Alaska: U. S. Geol. Survey Bull. 687, 1919. Brooks, A. H., The Alaskan mining industry in 1920: U. S. Geol. Survey Bull. 722, pp. 52–53, 1921.

deposit was opened up, and since then about 1,100 tons of ore has been shipped. The district is about 50 to 70 miles west of the Alaska Railroad, but it has no road connection with that line and the ore had to be transported by horse sleds to Kantishna River and thence by small steamers to the Tanana. This method of transportation was so expensive that only the richest ore would stand shipment. Therefore the galena ore was hand picked, the grade of shipments being thus brought to an average of about 140 ounces of silver and $3.25 in gold to the ton, in addition to the lead and some copper.

The lodes from which this ore came and others at near-by localities are at or near Eureka Creek. The deposits lie in well-defined fissures traversing schistose rocks and are associated with granitic intrusive rocks. Some of the ore bodies are 8 to 15 feet wide, but the rich galena is in shoots from 6 inches to 2½ feet in width. Gold-bearing quartz veins of similar type are also found in this part of the district, as well as some deposits of antimony (stibnite). The few openings made indicate that the lodes are fairly persistent along the strike.

Work was continued at Quigley's Red Top claims in 1921. The development consists of a drift which follows the ore for over 200 feet and at its face is 60 feet below the outcrop. The entire lode is from 3 to 10 feet wide, and the valuable ore occurs in shoots from 6 inches to 3 feet wide. These shoots are somewhat irregularly distributed along the lode, and surface pits indicate that the lode may be traced for 1,000 feet or more. The ore shoots contain much silver and considerable gold. The ore is esentially an argentiferous galena but carries some copper and zinc.

The Alice mine is the only other property in the district where any considerable underground work was done. Unfortunately, when it was visited in August, 1921, this mine was entirely inaccessible on account of caving. The ore body has been described by Stewart.[13] Assessment work is being done on many other gold and galena deposits in the district.

In 1921 sulphide-bearing lodes were discovered in the foothills of the Alaska Range, 20 miles southeast of Eureka Creek, in what is sometimes called the Copper Mountain district. These deposits were found in July by O. M. Grant and F. B. Jiles, both experienced prospectors, who staked 22 claims. They lie some 14 miles from timber, but lignite beds are close at hand. They are readily accessible to pack horses. The construction of about 50 miles of wagon road would connect the locality with the Alaska Railroad at Riley Creek. Granodiorite is the prevailing country rock of the region and is found both in large areas and as dikes. Banded and massive quartzites with some limestones and slate, cut by granodiorite dikes,

[13] Stewart, B. D., Territorial Mine Inspector Ann. Rept. for 1920, pp. 12–14, Juneau, 1921.

constitute the formations in which the ores have been found. The sedimentary beds are much deformed and trend a little north of west.

The ore bodies are distributed through a zone that trends a little north of east and thus apparently cuts across the bedding of the sediments. This zone has been traced about 2 miles and is reported to be longer. As determined by present discoveries, its width is from one-fourth to 1 mile. This zone is characterized by an abundance of sulphide minerals, concentrated in more or less well-defined ore bodies. Some of these bodies have definite walls; in others the ore grades into the country rock. They occur chiefly in the quartzites, but some are in the granodiorite and others at the contact between the two. As no excavation has been done it is difficult to give exact statements as to width. At some places there is evidence of sulphide mineralization over a width of about 100 feet, but in these places the rich sulphides appear to be limited to certain shoots. Most of the lodes are much smaller and consist of shoots in zones 10 to 25 feet wide. The ore consists chiefly of galena, chalcopyrite, zinc blende, pyrite, and bornite. Among these minerals galena appears to predominate. A granular intergrowth of galena with chalcopyrite appears to form the typical ore, but larger masses of pure galena are also found. The gangue consists of quartz and of the country rock, chiefly quartzite. In the absence of sampling or even of cuts exposing the ore, a definite statement of metallic content is not justified. The grab samples taken by owners of claims have yielded from 0.20 to 270 ounces of silver and from a trace to $8 in gold to the ton. Three samples carried from 1 to 8.8 per cent of copper.

No work had been done on the Grant & Jiles claims when they were examined in August, 1921, nor on the other prospects reported in the same region. Their value can therefore not be predicted, but the surface exposures fully justify careful prospecting.

Fourteen small gold placer mines, employing about 24 men, were operated in the Kantishna district in 1921. The largest operations were on Little Moose Creek. This mining was all done by pick and shovel, and the recovery of gold was about $1 to the cubic yard.

The most important development of the year consisted of the plans of two companies to operate hydraulic plants on a large scale. The Kantishna Hydraulic Mining Co. has built a ditch and flume from Wonder Lake and will mine a group of claims on Moose Creek at the mouth of Eureka Creek. The Mount McKinley Gold Placer Co. (Inc.) is developing a project to hydraulic placer ground on Caribou and Glacier creeks. Caribou Creek and tributaries are to be the immediate source of water for this project, but it is reported that water is also to be taken from Wonder Lake.

Placer gold and silver produced in the Kantishna district, 1903–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1903–1906.	8,465.62	$175,000	1,325	$795	1915.....	967.50	$20,000	152	$77
1907.....	725.62	15,000	114	75	1916.....	1,451.25	30,000	227	149
1908.....	725.62	15,000	114	60	1917.....	725.63	15,000	120	99
1909.....	241.87	5,000	38	20	1918.....	1,451.25	30,000	227	227
1910.....	483.75	10,000	76	41	1919.....	725.63	15,000	114	128
1911.....	1,451.25	30,000	227	120	1920.....	1,209.37	25,000	320	349
1912.....	1,451.25	30,000	227	140	1921.....	580.50	12,000	156	156
1913.....	1,451.25	30,000	227	137					
1914.....	967.50	20,000	152	84		23,074.86	477,000	3,816	2,657

RUBY DISTRICT.

The Ruby district has maintained its annual gold output for the last three years. Most of its gold has come from deep ground of rather high tenor. In 1921 the gravel sluiced averaged $4.50 in gold to the cubic yard. There were 21 mines operated in summer, employing 57 men, and 5 in the winter, employing 56 men. According to reports received all but four of these mines were operated in deep ground. The largest production came from Long, Flat, Poorman, and Solomon creeks.

Placer gold and silver produced in the Ruby district, 1907–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1907–8....	48.38	$1,000	7	$4	1918.....	19,350.00	$400,000	3,000	$3,000
1912.....	8,465.63	175,000	1,157	712	1919.....	7,981.88	165,000	1,255	1,406
1913.....	37,974.37	785,000	5,188	3,134	1920.....	8,223.75	170,000	1,113	1,213
1914.....	48,375.00	1,000,000	6,609	3,655	1921.....	8,223.75	170,000	1,158	1,158
1915.....	33,862.50	700,000	4,626	2,345					
1916.....	41,118.75	850,000	5,618	3,697		256,435.89	5,301,000	35,804	25,370
1917.....	42,811.88	885,000	6,073	5,046					

Galena veins cutting the schists of the Kaiyuh Mountains were discovered in September, 1918, at a locality near the headwaters of Bishop Creek, about 20 miles south of Yukon River at Louden and about 27 miles south of the new settlement of Galena, which is on the north bank of the Yukon opposite the lower end of Louden Slough, or about 15 miles below Louden. This locality was visited in July, 1921, by G. C. Martin, who has submitted the following description:

The galena prospects lie near the north end of the Kaiyuh Range, on the headwaters of Bishop Creek, which flows north-northeast for about 10 miles from the prospects, then takes an unknown meandering course across the flats, and enters the Yukon near Bishop Mountain. This region is also drained by Kalikaket Creek, which enters the upper end of Louden Slough. A summer trail leaving Louden

Slough 2 or 3 miles below its upper end and following the western slope of the ridge between Bishop and Kalikaket creeks leads to the prospects. The district is of moderate relief, most of the hills being 1,000 to 1,500 feet high and the higher peaks on the headwaters of Bishop and Kalikaket creeks reaching 2,000 or 2,500 feet. There is a thin scattered growth of spruce and birch throughout the region.

Near the prospects the country rocks are quartzose, micaceous, and chloritic schists and limestones. The exposures at the prospects are schists, the schistosity or bedding of which strikes northeast. A belt of limestone crosses Bishop Creek about half a mile above the prospects and is well exposed on the west side of the valley. It is a fine-grained limestone, not much recrystallized, resembling the limestone at Ruby. Its relations to the schists and its age are not known. The rocks of the Kaiyuh Mountains were described by Maddren [14] as quartzite and quartz-mica schists, with associated crystalline limestones, garnet schists, and fine-textured slaty schists or phyllites succeeded by ancient diabasic effusive rocks.

Ore is exposed only in the excavation, where it was discovered by stripping at a locality indicated by float. The workings, which had mostly caved in at the time of the visit, are said to show an irregular ore body up to 2 or 3 feet thick, broken up in places by bands and masses of rock that is barren or contains only scattered ore. The ore apparently contains no valuable minerals except silver-bearing galena. A blue stain on some of the ore is probably a mere tarnish not due to any foreign substances. Tests for copper and molybdenum gave negative results.

A small mine on the Perseverance claim was operated in the autumn and winter of 1920–21 under lease. At the same time the adjacent Valley claim was worked in a small way by the owners. The ore was sledded to the Yukon. In the summer of 1921 the Perseverance claim was being prospected by the owners, but no ore was being mined.

INNOKO AND TOLSTOI DISTRICTS.

In the Innoko district 23 summer mines, employing 85 men, and 5 winter mines, employing 10 men, were operated in 1921. The completion and operation for 50 days of a dredge on Yankee Creek was the most significant event of the year. Two other dredges were also on the way to the district—one to be installed on Yankee Creek and the other on Gaines Creek. Most of the mining in the district is done by open cuts, and four steam scrapers are reported to have been operated in 1921. An average of about $1.05 worth of gold to the cubic yard was recovered from the gravel sluiced. Some rich deep placer ground was discovered and developed in the summer on Victor Creek, near the wagon road about four miles south of Ophir. The largest gold production came from Little, Ophir, Yankee, and Gaines creeks.

The value of the gold output from the Tolstoi region was about $6,000. This was taken from five mines employing eight men.

[14] Maddren, A. G., The Innoko gold-placer district, Alaska: U. S. Geol. Survey Bull. 410, pp. 43–48, pl. 2, 1910.

Placer gold and silver produced in the Innoko and Tolstoi districts, 1907–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1907.....	628.87	$13,000	67	$44	1916.....	10,642.50	$220,000	1,130	$744
1908.....	3,483.00	72,000	370	196	1917.....	8,465.63	175,000	1,113	917
1909.....	16,447.50	340,000	1,746	908	1918.....	5,805.00	120,000	608	608
1910.....	15,721.87	325,000	1,669	901	1919.....	6,772.50	140,000	717	803
1911.....	12,093.75	250,000	1,284	681	1920.....	4,982.62	103,000	529	577
1912.....	12,093.75	250,000	1,284	681	1921.....	5,321.25	110,000	569	569
1913.....	13,545.00	280,000	1,438	869					
1914.....	9,675.00	200,000	1,027	568		134,869.49	2,788,000	14,527	9,561
1915.....	9,191.25	190,000	976	495					

IDITAROD DISTRICT.

There were 22 productive placer mines, employing 120 men, in the Iditarod district during the summer of 1921. The two dredges on Otter Creek worked for 140 days and were the largest plants operating in the district. Most of the gold output came from Otter, Flat, Chicken, and Willow creeks. Five steam scrapers and six hydraulic plants are reported to have been operated. The average gold recovery for the entire district was about 70 cents to the cubic yard. The operation of a quicksilver mine in the headwater region of Iditarod River is described on page 13.

Placer gold and silver produced in the Iditarod district, 1910–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1910.....	24,187.50	$500,000	4,254	$2,297	1917.....	72,562.50	$1,500,000	11,050	$9,105
1911.....	120,937.50	2,500,000	21,270	11,273	1918.....	59,985.00	1,240,000	9,000	9,000
1912.....	169,312.50	3,500,000	29,778	18,313	1919.....	35,071.88	725,000	5,300	5,937
1913.....	89,977.50	1,860,000	9,551	5,769	1920.....	24,429.37	505,000	3,628	3,954
1914.....	99,652.50	2,060,000	10,578	5,849	1921.....	16,931.25	350,000	2,482	2,482
1915.....	99,168.75	2,050,000	10,526	5,337					
1916.....	94,331.25	1,950,000	10,013	6,589		906,547.50	18,740,000	127,430	85,905

MARSHALL DISTRICT.

About nine mines, employing 35 men, were operated in the Marshall district of the lower Yukon during 1921. In the past most of the gold mined in this district has come from Willow Creek, where, however, the richest deposits have now been mined out. In 1921 there were only three productive mines in the older part of the district immediately tributary to Marshall (Fortuna Ledge post office). There was, however, considerable mining activity in the Stuyahok region, about 40 miles northeast of Marshall but only about 10 miles from the Yukon at Tuckers Landing. In the summer of 1921 there were about 50 prospectors in this region. Information about the occurrence of the gold is lacking.

Placer gold and silver produced in the Marshall district, 1914–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1914.....	725.62	$15,000	94	$52	1919.....	4,837.50	$100,000	624	$699
1915.....	1,209.37	25,000	156	79	1920.....	4,353.75	90,000	552	602
1916.....	13,061.25	270,000	1,686	1,109	1921.....	1,451.25	30,000	192	192
1917.....	20,559.37	425,000	3,300	2,719					
1918.....	7,256.25	150,000	940	940		53,454.36	1,105,000	7,544	6,392

INDIAN RIVER AND GOLD HILL DISTRICTS.

Nothing new was developed in the Indian River and Gold Hill districts in 1921. So far as known only four or five small mines were operated in this region during the summer.

Placer gold and silver produced in the Indian River and Gold Hill districts, 1911–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1911.....	483.75	$10,000	69	$37	1918.....	193.50	$4,000	29	$29
1912.....	1,185.19	24,500	170	105	1919.....	338.62	7,000	52	58
1913.....	1,548.00	32,000	221	133	1920.....	96.75	2,000	13	14
1914.....	1,209.37	25,000	173	96	1921.....	96.75	2,000	27	27
1915.....	725.63	15,000	104	53					
1916.....	483.75	10,000	69	45		6,603.19	136,500	954	619
1917.....	241.88	5,000	27	22					

CHANDALAR DISTRICT.

According to reports received three deep mines and one open-cut mine were operated in the Chandalar district in 1921 and employed 14 men in summer and 12 in winter. A number of other deep mines were under development but did not reach a productive stage. The richest placers thus far found are on Squaw Creek, where two of the operating mines were located. The two other mines were on Big Creek. Three men were engaged in mining on Bear Creek, a tributary of Hogatza River. There were probably some other small placer mines in the Chandalar district, from which no reports have been received. The region is so difficult of access as to discourage the systematic prospecting which the discoveries made fully justify. The gravel sluiced in 1921 carried an average of $5.20 to the cubic yard.

Placer gold and silver produced in the Chandalar district, 1906–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1906–1912.	2,902.50	$60,000	416	$241	1918.....	628.88	$13,000	96	$96
1913.....	266.06	5,500	38	23	1919.....	483.75	10,000	79	88
1914.....	241.87	5,000	35	19	1920.....	870.75	18,000	125	136
1915.....	241.87	5,000	35	18	1921.....	1,451.25	30,000	197	197
1916.....	435.37	9,000	62	41					
1917.....	725.63	15,000	104	86		8,247.93	170,500	1,187	945

KOYUKUK DISTRICT.

In the Koyukuk district 29 summer placer mines, employing 60 men, and 8 winter mines, employing 20 men, were productively operated in 1921. An average of $1.85 in gold to the cubic yard was recovered. The returns from 14 drift mines show an average gold recovery of $6.90 to the cubic yard, and those from 18 open-cut mines, including 3 hydraulic, show an average of $1.20 to the cubic yard. The largest output came from Nolan Creek. In the past most of the Koyukuk gold has been won from deep placers; the present tendency is to develop the more extensive shallow placers.

There are no productive lode mines in the Koyukuk district, but some galena ore has been found in the Wild River basin, 20 miles west of Coldfoot. Some development work has been done on a lode on Michigan Creek, a tributary of Wild River. These ores are said to occur in a limestone bedrock.

Placer gold and silver produced in the Koyukuk district, 1900–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1900–1909	106,454.02	$2,200,600	15,242	$8,993	1917	12,093.75	$250,000	1,700	$1,401
1910	7,740.00	160,000	1,108	598	1918	7,256.25	150,000	860	860
1911	6,772.50	140,000	970	514	1919	5,321.25	110,000	760	851
1912	9,675.00	200,000	1,385	852	1920	4,353.75	90,000	146	159
1913	19,350.00	400,000	2,770	1,673	1921	3,773.25	78,000	119	119
1914	12,577.50	260,000	1,800	995					
1915	13,303.12	275,000	1,902	964		223,666.64	4,623,600	30,909	19,392
1916	14,996.25	310,000	2,147	1,413					

KUSKOKWIM REGION.

The returns from the Kuskokwim region placer operators are still very incomplete, so that a full statement of mining in 1921 is not possible. About 30 mines were operated, and they produced about $520,000 worth of gold. The largest single operation was that of the dredge on Candle Creek near McGrath. Plans are under way for the installation of other dredges in the Kuskokwim basin. About 100 men were employed in productive mining in the Kuskokwim in the summer, but there was almost no winter placer mining. The placer mining in the Georgetown and Tuluksak-Aniak districts was of about equal extent, and a lesser amount was done around Goodnews Bay. The search for gold placers on Holitna River has been continued, with reported encouraging results.

Developments were continued at the Alaska Treadwell claims, near Nixon Fork, in the McKinley district. The company reports 2,297 linear feet of underground work during the year. A maximum depth of 290 feet has been reached in one of the shafts. The erection of a 10-stamp amalgamating and concentrating mill was completed at about the end of 1921. Some ore was taken from an open cut and a 12-foot shaft on the Gold Butte lode claims, near Akiak. There are reports of other gold-lode developments in the Kuskokwim region, but nothing very definite. The work on quicksilver deposits of the lower Kuskokwim is noted elsewhere (p. 13).

SEWARD PENINSULA.

SALIENT FEATURES.

The value of the total mineral production of Seward Peninsula in 1921 was $1,465,297, of which $1,455,085, as shown in the subjoined table, was in gold, and the rest in silver, platinum, and a little coal and lead. There was no tin mining in Seward Peninsula in 1921. The platinum came chiefly from the Koyuk district. A small output of lignitic coal came from the Fairhaven district. The Independence mine, in the Fairhaven district, was developed, and some galena ore was shipped. The owners of the property report that the underground work includes a 136-foot shaft and 250 feet of drifts on two levels. This was the only producing lode mine on the peninsula. A small lot of rich auriferous quartz, taken from a hydraulic pit near Nome, was shipped. The only other lode development consisted primarily of assessment work.

PLACER MINING.

A total of 126 placer mines, employing about 622 men, were operating on Seward Peninsula in the summer of 1921, and 14 mines, employing 64 men, the previous winter. In 1920 there were about 112 summer mines, employing 540 men, and 8 winter mines, employing 60 men. The average output for each summer mine was about $10,000 in 1921 and about $11,000 in 1920. For each man employed in the summer mines the value of gold recovered was about $2,340 in 1921 and $2,220 in 1920.

In 1921 there were 45 mines, employing 76 men, each of which produced $1,200 or less in gold. The production per man employed was only about $400, and the gravel that was sluiced had an average gold content of only $1.30 to the cubic yard. Even if due allowance is made for the fact that many of these small mines were operated only for a short time, it is nevertheless clear that they are operated at a loss. The only exception is where the productive mining is only incidental to the development of deposits that are later to be exploited on a larger scale.

Placer gold produced in Seward Peninsula in 1921, by districts.

District.	Value of gold.	Summer.		Winter.	
		Mines.	Miners.	Mines.	Miners.
Nome	$585,000	42	230	6	23
Solomon and Casadepaga	120,000	12	63	.....	.....
Koyuk	152,000	17	71	5	30
Council	420,000	8	101	.....	.....
Kougarok	45,000	20	51	1	3
Fairhaven	120,000	20	84	2	8
Port Clarence	8,000	7	22	.....	.....
	1,450,000	126	622	14	64

Placer gold produced in Seward Peninsula in 1921, by methods of mining.

Method.	Mines.	Men.	Value of gold.
Dredging	16	182	$690,000
Hydraulic mining (includes all operations where any water is used to move gravel to sluice box)	20	114	115,000
Open-cut mining (other than by hydraulicking)	74	241	451,000
Drifting	20	102	194,000

The 16 dredges operated on Seward Peninsula in 1921 dug about 1,690,000 cubic yards, as compared with 17 gold dredges and about 930,000 cubic yards in 1920. The gold recovery to the cubic yard was 41 cents in 1921 and 51 cents in 1920. The dredges were operated from 10 to 120 days. Those that were fully prepared at the beginning of the operating season worked from 90 to 120 days. The hydraulic mines handled about 162,000 cubic yards and made an average gold recovery of about 71 cents. About 40,000 cubic yards was mined by drifting and hoisting, with a gold recovery of about $5 to the cubic yard. Most of the deep mining was done in the Koyuk district.

Gold and silver produced on Seward Peninsula, 1897–1921.

Year.	Gold.		Silver.		Year.	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.		Fine ounces.	Value.	Fine ounces.	Value.
1897	725.63	$15,000	87	$52	1911	149,962.50	$3,100,000	17,996	$9,718
1898	3,628.12	75,000	435	256	1912	145,125.00	3,000,000	17,415	10,710
1899	135,450.00	2,800,000	16,254	9,752	1913	120,937.50	2,500,000	12,094	7,305
1900	229,781.25	4,750,000	27,574	17,097	1914	130,612.50	2,700,000	15,673	8,667
1901	199,822.61	4,130,700	24,579	14,747	1915	140,287.50	2,900,000	17,510	8,878
1902	220,677.07	4,561,800	26,481	14,035	1916	142,706.25	2,950,000	14,271	9,391
1903	215,994.38	4,465,000	24,171	13,052	1917	125,775.00	2,600,000	13,770	11,346
1904	201,462.52	4,164,600	24,175	14,021	1918	53,599.50	1,108,000	6,022	6,022
1905	232,200.00	4,800,000	27,864	16,997	1919	65,790.00	1,360,000	6,940	7,773
1906	352,812.50	7,500,000	43,537	29,605	1920	62,887.49	1,300,000	6,813	7,426
1907	338,625.00	7,000,000	25,497	16,828	1921	70,389.75	1,455,085	6,411	6,411
1908	247,680.00	5,120,000	20,577	10,905					
1909	207,077.50	4,260,000	20,871	10,853		3,963,322.07	82,115,185	437,334	272,818
1910	169,312.50	3,500,000	20,317	10,971					

KOBUK REGION.

Placer mining continued during 1921 in a small way in the Squirrel River and Shungnak districts of the Kobuk River basin. About a dozen placer mines were operated during the year, most of them for only a part of the season. About 12 men were employed at mining during the summer and 10 during the previous winter. The largest production came from Klery Creek, but the value of the total output was only about $7,000. The gravels mined carried from $1 to $5 a cubic yard in gold, but the average was only about $1.50.

ADMINISTRATIVE REPORT.

By ALFRED H. BROOKS.

During 1921 nine parties were engaged in surveys and investigations in Alaska. These parties included 9 geologists, 3 topographers, 1 topographic assistant, and 20 packers, cooks, and other auxiliaries. Six parties were engaged in geologic work, two in topographic survey, and one was a combined geologic and topographic party.

The funds available for field and office work for the season of 1921 included an appropriation of $75,000, an unexpended balance of $13,800 from the appropriation of the previous year, and an allotment of $12,000 from the appropriation of 1921 for the classification of the public lands. The subjoined tables show the allotments of these funds geographically by types of work and by salaries and field expenses. A balance of $5,430 will be used for the field work of 1922. In these tables the money devoted purely to office work has not been allocated to the several projects.

Allotments for salaries and field expenses, field season, 1921.

	1920-21	1921-22
Scientific salaries	$500	$30,490
Field expenses	22,670	21,340
Miscellaneous expenses, including clerical salaries, etc.	2,630	9,240
Office of Director	.....	8,500
To be allotted to field work, 1922	.....	5,430
	25,800	75,000

The allotments shown in the subjoined tables as made to different kinds of work and to different regions are only approximations. To determine the true figures would require an elaborate cost-keeping system too expensive to justify the results to be achieved. Many parties and individuals divide their time between two or more projects. The following two tables will show in a general way, however, on what projects the funds have been spent. The geologic surveys include work that is used in the classification of public lands.

Approximate distribution of allotments for investigations in Alaska, field season of 1921.

	1920–21	1921–22
Administration, Alaska branch		$5,700
General investigation, mineral resources		4,520
Southeastern Alaska	$1,900	7,700
Cook Inlet	9,000	11,170
Alaska Railroad		2,350
Alaska Peninsula	8,930	9,210
Yukon basin	3,340	7,300
Map compilation		4,660
Collecting mineral statistics		1,800
Miscellaneous expenses, including clerical salaries, etc	2,630	6,660
Office of Director		8,500
To be allotted to field work, 1922		5,430
	25,800	75,000

Approximate allotments to different kinds of surveys and investigations, field season of 1921.

	1920–21	1921–22
Administration, Alaska branch		$5,700
Special investigation of geology and mineral resources	$500	11,900
Reconnaissance geologic surveys	8,820	13,950
Detailed geologic surveys	4,200	7,200
Reconnaissance topographic surveys	4,850	4,100
Detailed topographic surveys	4,800	5,100
Map compilation		4,660
Collecting mineral statistics		1,800
Miscellaneous expenses, including clerical salaries, etc	2,630	6,660
Office of Director		8,500
To be allotted to field work, 1922		5,430
	25,800	75,000

The following table shows the progress of investigations in Alaska and the annual grants of funds since systematic surveys were begun, in 1898.[1] It should be noted that a varying amount is spent each year on special investigations that yield results which can not be expressed in terms of area. In 1917, when the United States entered the World War, nearly all the Alaska funds were allotted to the investigation of minerals such as platinum, sulphur, and antimony, which were then of special importance, and few areal surveys were made. Since 1918 the reduction of the annual appropriation and the increased cost of all field work has not permitted extensive geologic and topographic surveys. Little progress has therefore been made in extending the topographic and geologic mapping which is essential to obtain an adequate knowledge of mineral resources of the Territory.

[1] The Geological Survey made some investigations of the gold and coal deposits of the Pacific seaboard region in 1895 and of the Yukon region in 1896.

Progress of surveys in Alaska, 1898–1921.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources.	
		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).	Line 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	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....	.....
1899	25,000	6,000	.....	.....	8,690	.....	.....	.....	.....	.....	.....
1900	60,000	3,300	6,700	.....	630	11,150	.....	.....	.....	.....	.....
1901	60,000	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....	.....
1902	60,000	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....	.....
1903	60,000	5,000	8,000	96	.....	15,000	.....	.....	.....	.....	.....
1904	60,000	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000	5,000	4,000	421	.....	13,500	40	.....	.....	14	286
1907	80,000	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000	6,100	5,500	450	6,190	5,170	444	.....	.....	81	703
1910	90,000	.....	8,635	321	.....	13,815	36	.....	.....	69	429
1911	100,000	8,000	10,550	496	.....	14,460	246	.....	.....	68	309
1912	90,000	.....	2,000	525	.....	.....	298	.....	.....	69	381
1913	100,000	3,500	2,950	180	3,400	2,535	287	.....	.....	.....	.....
1914	100,000	1,000	7,700	325	600	10,300	10	.....	.....	.....	.....
1915	100,000	.....	10,700	200	.....	10,400	12	3	2	9	.....
1916	100,000	.....	5,100	636	.....	9,700	67	.....	.....	20	.....
1917	100,000	.....	1,750	275	.....	1,050	.....	.....	.....	19	.....
1918	77,000	.....	3,500	.....	.....	1,200	.....	.....	.....	.....	.....
1919	75,000	.....	2,700	.....	.....	2,300	.....	.....	.....	19	.....
1920	75,000	.....	1,480	.....	.....	770	.....	.....	.....	19	.....
1921	[b]87,000	.....	2,130	150	.....	300	205	.....	.....	.....	.....
	1,875,189	73,200	111,095	5,657	51,680	152,600	3,936	462	74	.....	.....
Percentage of total area of Alaska	.....	12.48	18.95	0.96	8.81	26.02	0.67	.....	.....	.....	.....

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

[b] Includes $12,000 for classification of public lands.

By order of the Director, dated April 1, 1922, the division of Alaskan mineral resources was changed to the Alaskan mineral resources branch, and its executive chief made the chief Alaskan geologist.

The writer was engaged in office work until August 3 and was absent in Alaska until October 10. He visited Anchorage, Kantishna, and Juneau and, in company with B. W. Dyer, Federal mine inspector, the Willow Creek district. A statement of results in the Kantishna and Willow Creek districts and on the petroleum seepage at Anchorage is published elsewhere in this volume. In addition to the time devoted to field work, including that of June, 1922, the writer during the fiscal year divided his time about as follows: Geologic studies, 10 days; progress report, 20; annual press bulletin, 4; field plans, 7; the preparation and delivery of lectures, 14; proof reading, 7; statistics, 13; critical reading and revision of manuscripts

of others, 7; attending scientific meetings, 8; and the preparation of an article on "The scientist in the Federal service," 32 days. The rest of his office time was devoted to administrative and routine matters.

R. H. Sargent was on furlough from March 18, 1920, to March 1, 1921. In September, 1921, he made a trip to southeastern Alaska to investigate areas and methods of topographic surveys. While in the office he was occupied chiefly in the administration of Alaska topographic surveys and map compilation.

A. F. Buddington spent from June 10 to September 16 in continuing the geologic mapping and investigation of mineral resources of the Wrangell district. A summary of his results is published elsewhere in this volume.

H. M. Eakin, geologist, was employed under contract to complete the report on the geology and mineral resources of Juneau and vicinity. He devoted one month to field work and about four months to office work.

A detailed geologic and topographic survey of the Iniskin oil field, on Cook Inlet was made, under the direction of F. H. Moffit. A. A. Baker assisted in the geologic work, and the topographic surveys were made by C. P. McKinley, assisted by Gerald Fitz Gerald. The topographic mapping was done from June 4 to August 30. On account of the marine strike, which delayed transportation, the main party did not begin field work until July 6. A preliminary edition of the topographic map of the Iniskin-Chinitna Peninsula has been issued. Mr. Moffit's results have been summarized in a press bulletin, issued in May, and are given at greater length elsewhere in this volume.

Richard K. Lynt was detailed to make topographic reconnaissance surveys in the Cold Bay district. On account of the very stormy weather of the summer, it was impossible to map more than 10 per cent of the most important part of the district. The field season extended from June 8 to September 4.

S. R. Capps, assisted by W. R. Smith, was employed in geologic reconnaissance surveys in the same district. The geologic surveys were greatly interfered with by the bad weather but covered about a third of the most important part of the district. Both parties were also greatly hampered by the seamen's strike, for as a consequence the steamer landing their horses did not arrive until July 2. A preliminary summary of Mr. Capps's results was published in May, and a more complete statement is contained in this volume. Mr. Capps devoted about one month to the continuation of his report on the geology and mineral resources of the region tributary to the Alaska Railroad. On April 16, 1922, he was furloughed

for one year to engage in commercial oil work for an American company in a foreign country.

The geologic mapping and study of the mineral resources of the Fairbanks quadrangle was continued by J. B. Mertie, jr., who devoted from June 30 to September 10 to the field work. Mr. Mertie's office work was chiefly given to the study of geologic notes and specimens from the Yukon-Tanana region, but he also completed the long-delayed report on the Ruby-Kuskokwim region.

George C. Martin was engaged from July 5 to August 31 in studying the geology and mineral resources of the lower Yukon and Koyukuk region. Most of his office time has been devoted to geologic studies of the Alaska Mesozoic formations.

C. Arthur Hollick was employed from February 16 to June 30 in continuing his studies of the Alaska Tertiary fossil plants. His results will have an important bearing on the correlation of the Alaska coal-bearing formations.

James McCormick was employed for five months in the revision of the geographic dictionary of Alaska. John H. Renshawe devoted about a month to the completion of the relief map of Alaska, now nearly ready for publication. John B. Torbert has been engaged in Alaska cartographic work throughout the year. About half of R. K. Lynt's office time has also been devoted to map compilation.

The lack of funds has prevented the continuation of stream gaging in southeastern Alaska. This work is essential to the determination of water powers available for mining, pulp-wood, and other industries. In cooperation with the Forest Service, stream gaging was carried on from 1915 to 1920, and the results obtained each year have been published annually. A summary of these annual reports is now being prepared.

Miss Lucy M. Graves, chief clerk, has continued to carry much of the burden of the administration of the Alaska branch and has acted as chief during the absence of the chief Alaskan geologist and of the senior geologist, G. C. Martin. The details of collecting the statistics of the mineral production of Alaska have been in the hands of T. R. Burch.

During 1921 the Survey issued two complete bulletins relating to Alaska—Bulletin 714, "Mineral resources of Alaska, 1919," by Alfred H. Brooks and others, and Bulletin 719, "Preliminary report on petroleum in Alaska," by George C. Martin—also the separate chapters from Bulletin 722, "Mineral resources of Alaska, 1920," by Alfred H. Brooks and others. A report, including topographic maps, "The geology of the York tin deposits, Alaska," by Edward Steidtmann and S. H. Cathcart, is in press as Bulletin 733, and another, "The Kotsina-Kuskulana district, Alaska," by F. H. Moffit and J. B. Mertie, jr., is nearly ready for the printer. The manuscripts of two

other reports—"The Ruby-Kuskokwim region, Alaska," by J. B. Mertie, jr., and G. L. Harrington, and "The Juneau district, Alaska," by H. M. Eakin—have been completed. The annual review of the mining industry of Alaska was issued as usual on December 31, 1921. In May, 1922, there was issued a press bulletin entitled "Petroleum in Alaska," which summarized the results of surveys made in 1921.

During the fiscal year 1922 the following Alaska maps were issued:

Kotsina-Kuskulana district, scale 1:62,500 (1 mile to the inch), by D. C. Witherspoon.

The Upper Tanana Valley region; scale 1:250,000 (4 miles to the inch), by D. C. Witherspoon and J. W. Bagley (preliminary edition).

Iniskin-Chinitna Peninsula; scale 1:62,500 (1 mile to the inch), by C. P. McKinley and Gerald Fitz Gerald (preliminary edition).

The compilation of the topographic map (scale 1:250,000) of the region tributary to the Alaska Railroad is approaching completion. This will be published in three sheets, of which the southern sheet (Seward-Matanuska) was sent to the engraver in June, 1922. A new map of Alaska (scale 1:2,500,000) has been compiled and is now in press. The drawing for a relief map on the same scale is almost completed.