ALASKA'S MINERAL RESOURCES AND PRODUCTION, 1923

By Alfred H. Brooks

GENERAL FEATURES

In 1923, in spite of the continuation of the high cost of all forms of mining and the low value of copper and other metals, more men than in 1922 engaged in the search for mineral wealth and a greater number of projects were under way in preparation for productive mining. In other words, the work of the prospector and that of the capitalist, guided by the mining engineer, showed advances during the year. There is good evidence that the widespread pessimism in regard to the Alaska mining industry that has persisted during the postwar period of financial depression is gradually disappearing. It has come to be realized that although the facts in hand about Alaska's mineral wealth show that the days of quick returns from the exploitation of bonanza placer mining, which are so favorable to local communities, are passed, yet there are in the Territory abundant mineral resources that can be profitably exploited by the use of improved mining methods. However, in practice these methods require the services of mining engineers and ample capital.

It is therefore evident that the Alaska mining industry has passed through its period of lowest depression and is now being gradually built up on a stable basis. This gain is, to a large extent, due to the improvement of the general business situation, but it has been greatly accelerated by a gradual lowering of mining costs through the betterment of transportation facilities. The mining public has come to realize that the Federal Government, by completing the trunk-line railroad from tidewater to the heart of Alaska, by affording better steamboat service on the Yukon, and by making more liberal grants for wagon roads and trails, has definitely embarked on a policy of fostering the mining industry, which has greatly stimulated mining advances. With the rapid exhaustion of the bonanzas, successful alluvial mining necessitates a greater use of power-driven machinery to recover the gold from Alaska's very large reserves of low-grade auriferous gravels, but such work is possible only in easily accessible districts. Lode gold, copper, and coal can, of course, be profitably mined only at localities served by steamers, railroads, or highways. The expansion of mining is possible only in districts served by reasonable freight rates. Twenty years ago 60 per cent of Alaska's mineral output came from remote districts not reached by well-organized transportation; in 1923 only 5 per cent came from similar isolated districts.

Though completed only a year ago, the Alaska Railroad has already stimulated mining development in the immediately tributary regions, but the contributions from these regions have not yet greatly increased the mineral output. In 1922 [1] the value of the mineral output from the railroad region was $1,840,000; in 1923 it was $2,080,000. The output in 1923 came from 170 small mines employing 1,000 men, not including the prospectors and others employed in nonproductive development, who will probably aggregate 500 more. The industrial population represented by these 1,500 employees is of course too small a number to support 500 miles of railroad. It should be regarded, however, as only the forerunner of a larger mining industry, which will be developed. This advance may be much accelerated by the building of wagon roads and trails as feeders to the railroad. The increase in a mining population will afford a greater market for the product of the farming lands tributary to the railroad. The increase in Alaska coal mining—though the output is still small—since the completion of the Government railroad has been all-important to Alaska industries. In 1914, when Alaska coal was first thrown open to utilization by the enactment of the leasing law, all but 1 per cent of the coal consumed in the Territory was imported, at heavy expense. In 1922 64 per cent and in 1923 70 per cent of the coal consumed in the Territory was obtained from the Alaska fields, at a cost per ton to the consumer much less than that of the imported coal.

Alaska is still dependent on imported petroleum, though she contains valuable oil fields now under development under the leasing law of 1920. It is to be expected that Alaska will soon supply her own mineral fuels. This means that with the utilization of her own abundant water power the Territory will in time become entirely self-supporting in the matter of sources of energy, a condition which will benefit all her industries.

Much has been said of the vast mineral reserves of Alaska, but nearly all of it has been based on information gleaned from geologic surveys that have covered less than a third of the Territory. Though the areas surveyed include most of the regions that have the greatest promise of mineral wealth, yet it is also true that the unsurveyed areas of Alaska are more than two and a half times as large as the surveyed areas, and there is reason to believe that they also contain districts of mineral importance. There is, for example, an unsurveyed area of 20,000 square miles lying between Cook Inlet on the east and Kuskokwim River on the west, in which copper, gold, and coal are reported and petroleum may occur along its eastern margin. In another unsurveyed area of about 3,000 square miles that extends eastward along the southern margin of the Tanana Valley from the

[1] The statistics in this report have been compiled by Miss E. C. Nichols.

Richardson Highway metal deposits are also reported. These two fairly accessible regions in central Alaska include areas equal to three times that of Massachusetts which are entirely unsurveyed and whose resources are wholly unknown and must therefore be ignored in an estimate of mineral wealth. Moreover, until this vast region is geologically surveyed it may not be regarded as a potential source of wealth to the Territory and hence of tonnage to the railroad. There are of course much larger unsurveyed areas in the more remote parts of Alaska, the investigation of which might disclose sources of mineral wealth, but the utilization of such sources is a matter of the future and does not affect the immediate situation, for the mining advances will first take place in the regions already made accessible. These facts are set forth to show that the prospector still has a large field outside of the areas that have already been productive of minerals.

The geologic survey of that part of Alaska that has been mapped has revealed a large array of facts on the potential mineral resources of the Territory. More concrete evidence of this is given by the statistics of mineral production. Mining began with the development of gold placers in 1880 in the Juneau district, where lode mining began two years later. The silver and lead output of Alaska has nearly all been won incidentally to the exploitation of gold and copper deposits. Silver and lead have been recovered in recent years from Alaska galena deposits.[2] A little coal has long been annually mined in Alaska, but a noteworthy production began in 1917. Gypsum mining began in 1906, and marble quarrying in 1901. The production of Alaska tin began in 1902, and platinum in 1916. Antimony, tungsten, and chromite were mined in Alaska during the period of urgent demands caused by the war. A little petroleum has been produced annually in the Katalla field since 1907. At various times quicksilver, graphite, abrasives, and limestone have also been produced in Alaska.

As shown in the following table, Alaska mines have since 1880 produced $517,627,000 worth of minerals, all raw material except that between 1905 and 1909 some copper ores were smelted in the Ketchikan district. During 43 years of mining in Alaska the Territory has made an output of $517,627,000 worth of minerals, of which over 50 per cent has been produced during the last decade.

The total mineral production, both by years and by substances, is given in the subjoined table, which differs somewhat from those previously published. The figures here presented are probably for the most part as accurate as can ever be determined, for the statistics of the first 25 years of mining were not systematically collected. There are, however, some data on the silver and lead output of the earlier years that may slightly modify the figures here presented.

[2] A little galena was produced at the Omalik mine, Seward Peninsula, as early as 1881.

Value of total mineral production of Alaska, 1880–1923

By years				By substances	
1880–1890	$4, 193, 919	1908	$20, 092, 501	Gold	$340, 955, 074
1891	1, 014, 211	1909	21, 140, 810	Copper	158, 109, 158
1892	1, 019, 493	1910	16, 875, 226	Silver	9, 501, 934
1893	1, 104, 962	1911	20, 720, 480	Coal	3, 580, 500
1894	1, 339, 332	1912	22, 581, 943	Tin	939, 199
1895	2, 588, 832	1913	19, 547, 292	Lead	829, 414
1896	2, 885, 029	1914	19, 109, 731	Platinum	285, 084
1897	2, 539, 294	1915	32, 790, 344	Antimony	237, 500
1898	2, 329, 016	1916	48, 386, 508	Marble, etc	3, 189, 080
1899	5, 425, 262	1917	40, 694, 804		
1900	7, 995, 209	1918	28, 218, 935		517, 626, 943
1901	7, 306, 381	1919	19, 626, 824		
1902	8, 475, 813	1920	23, 330, 586		
1903	9, 088, 564	1921	16, 994, 302		
1904	9, 627, 495	1922	19, 420, 121		
1905	16, 490, 720	1923	20, 330, 643		
1906	23, 501, 770				
1907	20, 840, 571		517, 626, 943		

In 1906 the value of the annual mineral production first exceeded $10,000,000, and from that time to the beginning of the World War it ranged from over $16,000,000 to nearly $23,000,000. This was the period of maximum output from the bonanza placers; then came the war period (1915–1918), when the value of the annual output, chiefly copper, was from $28,000,000 to $48,000,000. During the postwar epoch the value of the annual mineral output has been about $20,000,000, which is greater than that of the pre-war decade. Measured by the value of the annual output, the industry has reached its pre-war prosperity, though this is only because the increased output of copper has more than made up for the falling off in gold mining. The value of the total mineral output in 1923 was greater than that of the previous year, as shown in the following table:

Mineral output of Alaska, 1922 and 1923

	1922		1923		Decrease or increase in 1923	
	Quantity	Value	Quantity	Value	Quantity	Value
Gold .... fine ounces	359, 057	$7, 422, 367	289, 539	$5, 985, 314	−69, 518	−$1, 437, 053
Copper .... pounds	77, 967, 819	10, 525, 655	85, 920, 645	12, 630, 335	+7, 952, 826	+2, 104, 680
Silver .... fine ounces	729, 945	729, 945	814, 649	668, 012	+84, 704	−61, 933
Coal .... short tons	79, 275	430, 639	119, 826	755, 469	+40, 551	+324, 830
Tin, metallic .... do	1. 40	912	1. 90	1, 623	+. 50	+711
Lead .... do	377	41, 477	410	57, 400	+33	+15, 923
Platinum metals. fine ounces	28. 30	2, 830	25. 90	3, 004	−2. 40	+174
Miscellaneous nonmetallic products, including petroleum, marble, and gypsum		266, 296		229, 486		−36, 810
		19, 420, 121		20, 330, 643		+910, 522

Compared with 1922 and measured by production, gold mining decreased about 20 per cent, copper mining increased 10 per cent, and coal mining increased 50 per cent in 1923. Though the value of the total mineral output of 1923 is greater than that of 1922, it should be noted that this increase is due almost entirely to the output of three large copper mines. On the other hand, the systematic drilling for oil and the increased lode-mining development are very encouraging features of the industry.

In 1880 mining was begun at Juneau by a score or two of prospectors. During the next decade the mining population gradually increased, but it did not aggregate more than 6,000 men employed in profitable mining until 1900, during the Nome gold rush. From that time until the present there have always been a greater number of men employed in placer work than in any other form of mining. Such employment, however, is limited to 100 to 150 days in the year. The gradual stabilization of the mining industry is shown by the fact that each year there is a greater percentage of the mine labor employed in other than placer mining.

Estimates of number of men employed at productive mines of Alaska in 1890, 1900, and 1910–1923 [a]

Year	Placer mines		Lode mines and reduction plants	All other mining and quarrying	Total, not including winter placer mines
	Summer	Winter (omitted from total)			
1890 [b]	175		200		375
1900 [b]	5,000		1,200	20	6,220
1910 [b]	5,500		2,000	120	7,620
1911	4,900	670	2,360	150	7,410
1912	4,500	900	2,500	150	7,150
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	4,200	340	8,590
1917	3,550	950	3,220	270	7,040
1918	3,000	610	1,897	400	5,297
1919	2,180	320	1,757	310	4,247
1920	1,990	340	1,880	360	4,230
1921	2,150	460	1,681	400	4,231
1922	2,198	402	1,623	280	4,101
1923	2,081	287	1,500	270	3,851

[a] Placer miners by the Geological Survey. Other figures chiefly from reports of Federal and Territorial mine inspectors.
[b] Figures only approximate.

GOLD AND SILVER

GENERAL STATISTICS

The Alaska gold miner shares with his colleagues in the rest of the world the disability produced by present economic conditions, which cause very high costs of operation, while the value of his product remains fixed. It can not be foreseen what the future holds forth for gold mining, but two conclusions appear to be justified. The period of maximum costs has passed; but, on the other hand, the general economic conditions reveal no evidence that there will be any marked reduction of costs in the immediate future. The Alaska gold miner must therefore plan for a future under the present operating costs, except in so far as these are reduced by a cheapening of transportation, brought about by improvement of rail and highway service.

Alaska gold-mining methods as developed at the Juneau lodes and in dredging are examples of what can be accomplished in reducing mining costs and compare favorably with the methods used in similar operations in more accessible parts of the world. How far these methods can be applied elsewhere in the Territory is the problem of the engineer.

The gold output of 1923 makes a remarkable showing considering the lesser number of large lode mines and the unusual lack of water because of the dry summer in many of the placer districts. In spite of the adverse conditions that now confront gold mining, the outlook for an increased gold output in the immediate future is good, because of the increase of dredging and the marked advances that are being made in the development of the higher grade of auriferous lodes in many widely separated localities. Under present economic conditions there seems to be no likelihood that large projects will be launched involving the exploitation of the large bodies of quartz lodes having only a low gold tenor.

The subjoined table shows the total gold and silver output of Alaska from lode and placer mines by years. It includes the gold recovered from copper ores, which is given in detail in a later table (p. 9). The figures given in this table differ somewhat from those previously published, owing to the revision of the estimates of output of the first 25 years of mining, for which there are no accurate statistics.

Gold and silver produced in Alaska, 1880–1923

Year	Gold		Silver		Value of gold by sources	
	Fine ounces	Value	Fine ounces	Commercial value	Placer mines	Lode mines
1880	290	$6,000			$6,000	
1881	726	15,000			15,000	
1882	1,113	23,000			20,000	$3,000
1883	2,709	56,000	10,320	$11,146	51,000	5,000
1884	3,483	72,000			51,000	21,000
1885	20,559	425,000			125,000	300,000
1886	26,123	540,000			150,000	390,000
1887	31,782	657,000			130,000	527,000
1888	32,169	665,000	2,320	2,181	135,000	530,000
1889	40,635	840,000	8,000	7,490	140,000	700,000
1890	40,151	830,000	7,500	6,071	150,000	680,000
1891	48,375	1,000,000	8,000	7,920	220,000	780,000
1892	48,617	1,005,000	8,000	7,000	240,000	765,000
1893	52,729	1,090,000	8,400	6,570	250,000	840,000
1894	63,855	1,320,000	22,261	14,257	450,000	870,000
1895	122,582	2,534,000	67,200	44,222	809,000	1,725,000
1896	134,483	2,780,000	145,300	99,087	960,000	1,820,000
1897	117,793	2,435,000	116,400	70,741	665,000	1,770,000
1898	108,602	2,245,000	92,400	54,575	645,000	1,600,000
1899	257,113	5,315,000	140,100	84,276	3,480,000	1,835,000
1900	381,921	7,895,000	73,300	45,494	5,623,000	2,272,000
1901	348,300	7,200,000	47,900	28,598	4,980,000	2,220,000
1902	403,206	8,335,000	92,000	48,590	5,887,000	2,448,000
1903	423,185	8,748,000	143,600	77,843	6,010,000	2,738,000
1904	440,938	9,115,000	198,700	114,934	6,025,000	3,090,000
1905	766,550	15,846,000	132,174	80,165	12,340,000	3,506,000
1906	1,066,030	22,036,794	203,500	136,345	18,607,000	3,429,794
1907	936,043	19,349,743	149,784	98,857	16,491,000	2,858,743
1908	933,290	19,292,818	135,672	71,906	15,888,000	3,404,818
1909	987,417	20,411,716	147,950	76,934	16,252,638	4,159,078
1910	780,131	16,126,749	157,850	85,239	11,984,806	4,141,943
1911	815,276	16,853,256	460,231	243,923	12,540,000	4,313,256
1912	829,436	17,145,951	515,186	316,839	11,990,000	5,155,951
1913	755,947	15,626,813	362,563	218,988	10,680,000	4,946,813
1914	762,596	15,764,259	394,805	218,327	10,730,000	5,034,259
1915	807,966	16,702,144	1,071,782	543,393	10,480,000	6,222,144
1916	834,068	17,241,713	1,379,171	907,495	11,140,000	6,101,713
1917	709,049	14,657,353	1,239,150	1,021,060	9,810,000	4,847,353
1918	458,641	9,480,952	847,789	847,789	5,900,000	3,580,952
1919	455,984	9,426,032	629,708	705,273	4,970,000	4,456,032
1920	404,683	8,365,560	953,546	1,039,364	3,873,000	4,492,560
1921	390,558	8,073,540	761,085	761,085	4,226,000	3,847,540
1922	359,057	7,422,367	729,945	729,945	4,395,000	3,027,367
1923	289,539	5,985,314	814,649	668,012	3,608,500	2,376,814
	16,493,700	340,955,074	12,278,241	9,501,934	233,122,944	107,832,130

Gold and silver produced in Alaska, 1923, by sources

Source	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value
Siliceous ores (2,502,901 short tons)	113,274.71	$2,341,596	57,763	$47,365
Copper ores (731,168 short tons)	1,627.00	33,633	715,040	586,333
Lead ores (123 short tons)	76.67	1,585	19,474	15,969
Placers (6,015,595 cubic yards of gravel)	174,561.18	3,608,500	22,372	18,345
	289,539.56	5,985,314	814,649	668,012

GOLD LODES

Southeastern Alaska continues to be the scene of the most important gold lode discoveries and development in the Territory, both because the physical conditions favor economical development and because the geologic history of the region has brought about a wide distribution of the auriferous deposits. Everywhere in southeastern Alaska the gold deposits are closely associated with the granitic intrusive rocks.[3] The largest belt of intrusives is that which forms the country rock of the Coast Range. Along its western margin is an auriferous zone where gold was first mined over 40 years ago. Here the alluvial gold deposits were the first to excite interest, for they were rich enough to mine in spite of the fact that the geologic conditions were not especially favorable to the formation of rich placers. During glacial time the huge ice masses advanced through the valleys and swept away and scattered any concentrations of gold that had been formed during the preceding epochs of bedrock erosion and deposition of gravel, and the present gold-bearing gravels were deposited after the glaciation of the region.

The results of auriferous mineralization along the western margin of the Coast Range belt of granite are best known in the Juneau gold belt, along which profitable mining has been done at scattered localities, stretching from Windham Bay on the south to Berners Bay on the north, a distance of 100 miles. Some evidence of the extension of this auriferous belt throughout southeastern Alaska is afforded by the discovery of gold placers and some small gold quartz veins at its north end, in the Porcupine placer district, and to the south, in the Ketchikan district. The Porcupine district produced some $700,000 worth of gold between 1898 and 1906, after which mining there practically ceased, not because the deposits were worked out but because there were then more attractive fields in Alaska. Now systematic development is under way to mine these deposits by hydraulic means, for which they are favorably located as regards water supply and stream gradients. The gold lodes of the Ketchikan district have received attention at various times for many years, and in 1923 work was more systematically undertaken at Helm Bay, on Cleveland Peninsula. The evidence thus indicates the presence of a gold belt extending along the the western margin of the Coast Range belt of granite from the Porcupine district to the Ketchikan district, a distance of some 350 miles. The width of this gold belt has not yet been accurately determined, except at Juneau, where the auriferous deposits occur in a zone about 3 miles in width. This, of course, does not mean that the entire zone is auriferous, for the metallization was confined to certain bands of country rock lying within the zone.

[3] These intrusives, which can be conveniently grouped together as "granitic," range in composition from granite to diorite.

To the south and north of the Juneau gold belt the auriferous zone is narrow and is far less well defined. Broadly speaking, the entire Coast Range zone may be regarded as a site of future mineral discoveries.

The enormous output from large lode deposits carrying a low percentage of gold at Juneau should not obscure the fact that the zone includes many richer ore shoots that have been profitably mined on a small scale. It is the latter type of deposit which at present is likely to attract the miner, for in spite of the continued success of the mining at the Alaska Juneau mine, capitalists are not likely to enter into similar new ventures in gold mining under present economic conditions.

It has long been known that some metallization has occurred along the eastern margin of the Coast Range belt of granite, which is for the most part on the Canadian side of the international boundary. This gold and silver bearing zone, though long prospected, had attracted no great attention until the development of the great Premier mine in 1918. This mine is on the Canadian side but close to the boundary, and when its development showed it to include a large ore body carrying a high silver content with some gold, many miners were attracted to the adjacent Hyder district in Alaska. The work of 1923 showed an extension of the metallized belt of the district beyond that previously known.[4] Though thus far only test shipments have been made from the Hyder district, an early and regular production from this camp is to be expected.

There is good reason to believe that a metallized zone extends along the entire eastern margin of the Coast Range belt of granite. Evidence of such a zone has been found along Unuk, Stikine, and Taku rivers, as well as near the White Pass Railroad, but it probably lies chiefly on the Canadian side of the boundary. Alaska will, however, receive at least an indirect benefit from any mining in this belt.

A. F. Buddington has found evidence that there are within the Coast Range granite belt some bodies of schist which in places are metallized. These schists are for the most part in rather inaccessible localities within the higher part of the range. The commercial value of the deposits, which carry silver and gold, is yet to be determined, but they serve to indicate that the area mapped as granite may include zones of commercial ore bodies, provided they are rendered accessible.

A belt of granite intrusives stretches through the central part of Chichagof Island and extends southward into Baranof Island. A metallized zone has been found along the western margin of this granite belt, in which lie the Chichagof and Hirst-Chichagof mines. Farther away from the granite but in the same general zones are the auriferous veins south of Sitka, which were the first to be discovered

[4] The ores of the Hyder district are described by A. F. Buddington in another part of this volume.

in Alaska. Evidence of auriferous mineralization has also been found near the eastern margin of the Chichagof belt of granite, notably on Lisianski Inlet, where work is being markedly advanced at the Apex mine.

In addition to these main granite belts, there are in southeastern Alaska many scattered smaller granite areas, along the margins of which gold and silver deposits have been found. An example of such an area is found near Funter Bay, near the north end of Admiralty Island, where the Pekovich, Alaska Dano, and Williams gold properties are being developed.

The geologic association of the auriferous lodes with the granite intrusives in southeastern Alaska, an association which, indeed, is common to most of the Alaska gold deposits, has long been known.[5] It is here again noted as evidence that there are large areas in the Panhandle in which there are strong hopes of new discoveries, and therefore the future of gold mining is not to be measured by the present discoveries. Gold-bearing quartz was mined in a small way at Sitka in 1879, and yet it was not until 1905 that the northern extension of this belt was recognized by the discovery of the deposit worked by the famous Chichagof mine. In spite of the accessibility of southeastern Alaska, prospecting in this region is difficult because a heavy mat of vegetation mantles the bedrock.

The genetic relation between gold lodes and igneous stocks and dikes is illustrated by the deposits on Prince William Sound and Kenai Peninsula. Here gold mining has been continued in a small way for many years, but no large or very rich ore bodies have been found. In 1923 a new gold-bearing lode was found on Nuka Bay, in the southwestern part of Kenai Peninsula. This region has long been known to be gold bearing,[6] but the new discovery is reported to be promising enough to attract considerable interest.

The Willow Creek district has been a producer of lode gold since 1908. The geology of the district is well known, and the surface croppings show that the lodes are persistent along the strike. Most of the mining has been done at shallow depths, and many rich shoots of ore have been found. No considerable quantity of ore has been developed, and until this is done no large production of gold is to be expected. If these gold veins are proved to be persistent at greater depth, the prospector will no doubt extend his search into adjacent regions. The margin of the granite zone stretches parallel to the Matanuska Valley for 20 to 30 miles, northeast of the Willow Creek district and about 10 to 15 miles from the railroad. Some of the streams cutting along this margin are known to carry a little

---

[5] Spencer, A. C., The Juneau gold belt: U. S. Geol. Survey Bull. 287, pp. 21–22, 1906.

[6] Grant, U. S., Geology and mineral resources of Kenai Peninsula: U. S. Geol. Survey Bull. 587, pp. 229–230, 1915.

alluvial gold. This zone seems well worth prospecting for auriferous lodes, though none have yet been discovered, so far as known. The granite margin extends from Kaskawulsh River, north of the Willow Creek district, northeastward for 20 miles to Sheep Creek, and this zone also is worth prospecting.

In 1923 a deposit of ruby silver, the first found in Alaska, was discovered on Portage Creek, 12 miles from Chulitna station on the Alaska Railroad. The geologic occurrence of this ore is unknown, but it may prove to be an indication of a new source of valuable mineral.

For reasons unknown the development of gold lodes in the Fairbanks district was unexpectedly small, considering that the region is now readily accessible by rail and wagon roads. No new discoveries of gold lodes were reported, and mining was practically restricted to small operations at three mines, which made only small outputs. As the district has been proved by underground work to contain some small but fairly rich veins though no large ore bodies, productive mining is to be expected at an early date. The auriferous mineralization here, as elsewhere in Alaska, occurred near the margins of granitic intrusives.

The ores of the Kantishna district occur both in schist, like those at Fairbanks, and in slate and limestone, but both types appear to be genetically related to igneous intrusives. They are essentially galena ores, some of which carry much silver and some gold. Copper, zinc, and antimony ores have also been found in the district. Under the present high transportation charges it has been found that even the richest galena ores, on which there were two operations in 1923, can not be mined at a profit. This condition will be changed when the district is reached by a wagon road, now being built from the railroad.

A belt of slate and limestone has been traced for 100 miles to the southwest of the Kantishna district, along the inland front of the Alaska Range, and granitic intrusives are also present. Deposits of gold, silver, and copper have been found at several places in this region, and some ore bodies have been reported. The geology of the region appears favorable for the occurrence of valuable metals, but of this there is as yet no definite evidence.

A rather ill-defined auriferous belt stretches from the Ruby district, on the Yukon, to the southwest, including the Innoko and Iditarod districts. Its southwest limit is marked by the placers of the Kuskokwim region. The gold deposits of this belt occur along the margins of granitic intrusives, and their linear arrangement is probably due to the fact that the granites were intruded along one general axis of deformation. In this general belt the gold mineralization was intimately associated with the granite. There has long been some quartz prospecting in this region, but on account of high transportation costs lode mining has been slow of development. Some prominsing lodes are said to have been prospected in the Iditarod district during 1923.

The distribution of placer gold in the Iditarod district suggests that its occurrence in bedrock is probably more concentrated here than in most other Yukon districts. Most of the placer gold of the Iditarod district has been recovered from the gravel of streams like Flat, Happy, and Chicken creeks, which have their sources in a single granite dome. Some auriferous zones occur in this granite, a fact which suggests that there may be a considerable body of granite that contains gold enough to constitute a low-grade ore. Under existing conditions this material could not be profitably mined, and the auriferous lodes which have received consideration are richer veins that penetrate the limestone and slate adjacent to the intrusive granite.

Gold and silver produced from gold-lode mines in Alaska in 1923, by districts

District	Number of mines	Ore mined (short tons)	Gold		Silver		Average value per ton of ore in gold and silver
			Fine ounces	Value	Fine ounces	Value	
Southeastern Alaska	5	[a] 2,489,280	95,341.85	$1,970,891	53,825	$44,137	[b] $0.81
Willow Creek	6	9,132	8,622.29	178,238	912	748	19.60
Fairbanks district	3	1,270	1,190.77	24,616	300	246	19.58
Other districts	5	[a] 3,342	8,196.47	169,436	22,200	18,203	56.15
	19	2,503,024	113,351.38	2,343,181	77,237	63,334	[b] .96

[a] Including small amounts of galena ore.
[b] Average value of ore milled, southeastern Alaska $1.77, total Alaska, $2.07.

As shown in the above table, 19 gold and silver lode mines were operated in Alaska during 1923; in 1922 there were 25. Some gold and silver was also produced from half a dozen other lode properties incidentally to development. The low average recovery of gold and silver per ton of ore from southeastern Alaska, as well as from the total quantity mined in the Territory, is due to the overwhelming output of ore from the Alaska Juneau mine. The figures given in the table include all the ore mined by the Alaska Juneau, of which over half is rejected after coarse crushing and hand sorting. If this were not included, the value of the average gold and silver content of the southeastern Alaska ores would be $1.77, and of all Alaska ores $2.07. Though the auriferous lode discoveries and developments during the year were very encouraging, yet so far as producing mines are concerned the status is even less favorable than the above table would indicate. Of the 19 mines classed as productive, only nine made an output of $10,000 worth of gold or more, and only three exceeded

$100,000. The present outlook in regard to Alaska lode mines indicates small rather than large operations.

The Alaska Juneau, the only productive mine in the Juneau district and the largest in the Territory, was operated throughout the year. The Chichagof, in the Sitka district, was operated until July, when the property was taken over by a new management, which expects to resume operations in 1924. Close to it is the Hirst-Chichagof, which was operated on a small scale. In the Ketchikan district the Julia (Kasaan Gold), on Prince of Wales Island, and the Helm Bay King, on Cleveland Peninsula, were operated on a small scale. Productive mining was also done on the North Midas, in Chitina Valley; the Tuscarora, near Valdez; and the Lucky Strike, on Kenai Peninsula, all gold properties. In the Willow Creek district gold was produced at the Gold Bullion, Lucky Shot, and War Baby, of the Willow Creek Mines, and at the Mabel and Fern Gold mines. There was also a small gold output from prospects under development. The gold from the Fairbanks district came chiefly from the Mohawk, Smith Bros., and Crites & Feldman mines. The Nixon mine was the only productive lode property in the Kuskokwim basin.

GOLD PLACERS

THE DEPOSITS

Distribution and yield.—Auriferous gravel is very widely distributed in Alaska, for it has been found in the streams of southeastern Alaska and of the Copper, Susitna, Kuskokwim, Yukon, Kobuk, and Noatak basins, as well as those of Seward Peninsula. It also occurs in a few streams of Alaska Peninsula and in the beach gravel at a number of places along the Pacific shore line. In almost all these regions fine particles of alluvial gold are present in the stream gravel, but only in certain ones have workable gold placers been developed. A placer can be defined as a deposit of sand, gravel, and other loose material containing a sufficient percentage of gold or other valuable minerals to permit its profitable recovery. It is evident that profitable mining of auriferous gravel will depend on its accessibility, as well as on the ease of its excavation and on the gold content. Under the expensive mining methods used by the Alaska pioneer, gravel carrying less than $5 worth of gold to the cubic yard could seldom be profitably exploited. In contrast to this, the gradual increase in profitable operation of lower-grade placers in Alaska is shown in the subjoined table. This table is based in part on estimates, and therefore the figures are by no means exact, but they are near enough to the truth to indicate the marked decline in the average gold recovery to the cubic yard.

Gravel sluiced in Alaskan placer mines and value of gold recovered, 1908–1923

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 cubi yard
1908	4, 275, 000	$3. 74	1916	7, 100, 000	$1. 75
1909	4, 418, 000	3. 66	1917	7, 000, 000	1. 40
1910	4, 036, 000	2. 97	1918	4, 931, 000	1. 20
1911	5, 790, 000	2. 17	1919	4, 548, 000	1. 10
1912	7, 050, 000	1. 70	1920	3, 439, 900	1. 13
1913	6, 800, 000	1. 57	1921	4, 812, 700	. 88
1904	8, 500, 000	1. 26	1922	5, 226, 000	. 84
1915	8, 100, 000	1. 29	1923	6, 015, 595	. 60

The average gold recovery to the cubic yard for all forms of placer mining in 1923 was only 60 cents and for dredging only 40 cents. An estimate of the gold placer reserves of Alaska must take account of the cost of mining, for, on the one hand, deposits of auriferous gravel whose gold content and cost of mining has not been determined must not be included, and, on the other hand, a given deposit of placer gold must not be ignored becaues of its present inaccessibility or because the cheapest form of mining has not been contemplated.

The above table covers all placer-mining operations. The figures are somewhat misleading owing to the fact that, especially in the later years, a few unprofitable mining ventures are included. Eventually such errors in judgment are abandoned, but while they are continued they affect the significance of the total averages. It seems probable that under present economic conditions the average value of the gold recovery per cubic yard will not admit of any reduction.

Types.—The gold of placer deposits has its original source in bedrock. Therefore, the first requisite to the formation of placers is the separation of the gold from the hard rock by weathering and abrasion. The gold of the bedrock may occur in rich lodes, from which little concentration is necessary to form a workable placer. This concentration may be almost nothing except the process of weathering, or it may be increased by the action of gravity which carries the auriferous débris. More commonly the gold is disseminated in the bedrock and forms placers only after water sorting and transportation.

The most valuable Alaska placers are those which have been formed by water transportation, either as stream deposits or beach deposits. The stream placers are the most extensive, for the beach placers, though some are of extraordinary richness, are usually too small to permit large-scale mining operations. Some placers have been formed by gravel of glacial origin, though in general deposits of this type are not of any great richness. Geologically the Alaska placers are chiefly of Recent formation. Among the deeply buried and elevated placers there are deposits believed to be of Pleistocene age. In the Yentna district Mr. Capps has found gold placers in early Tertiary sediments, resting on weathered pre-Tertiary rocks, and there are probably other occurrences of this age in Alaska.

It has been shown that alluvial gold is derived by weathering from bedrock deposits, and placers are formed by subsequent concentration through gravity and water sorting and transportation. The process of water sorting may be repeated in later erosion cycles that reconcentrate the alluvial gold and therefore form richer placers, which are called "re-sorted placers." The following classification of Alaska placers [7] is essentially genetic:

I. Residual: Rest directly on bedrock source of gold, from which the gold has been separated by weathering.
II. Eluvial: Concentrated by gravity, which has led to soil creep down a slope, but without sorting by running water.
III. Fluviatile: Sorted and transported by running water:
  1. Present streams.
  2. Ancient streams: Deposited in former watercourses:
    a. Bench deposits.
    b. Buried channel deposits.
IV. Beach: Formed by marine erosion and deposition:
  1. Present shore line.
  2. Ancient shore line:
    a. Elevated beaches.
    b. Depressed beaches.
V. Glacio-fluviatile: Fluviatile deposits of débris formed by glacial erosion.
VI. Re-sorted: Deposits formed by the erosion of old placers and the reconcentration of their gold content:
  1. Fluviatile.
  2. Marine (beach).

Most placer gold was originally derived from residual deposits, though in some placers the process of weathering has had little influence, for the metal was separated from bedrock chiefly by water abrasion. As there is a constant tendency for all weathered material to move down the slopes, most residual gold soon becomes eluvial, in which there is a tendency toward the concentration of the heavy material. When sorting and transportation by running water take place the third and last stage in the formation of a placer formed in one erosion cycle has been reached, and the deposit is a fluviatile placer. The fluviatile placers may occur in the gravel in the present streams or may have been formed in the streams of an older erosion cycle, evidence of which may be preserved in benches above the present valley bottoms or in buried channels lying far below them.

Beach placers represent a special type of formation along present or ancient shore lines. Many of these are of the re-sorted type, for the gold, accumulated by wave action, may be derived from older fluviatile placers of the coastal plain. Gradual elevation may give a series of beach placers, which by merging into one another may

[7] This subject has been discussed by the writer in U. S. Geol. Survey Bull. 328, pp. 111-139, and Bull. 592, pp. 27-32, and by J. B. Mertie, jr., in Bull. 739, pp. 160-162.

constitute an almost continuous placer. More commonly, however, the individual beaches stretching parallel to the coast are very sharply bounded.

The glaciation of a region is usually unfavorable to the formation of placers. Ice erosion sweeps away the decomposed bedrock and stream gravel and dissipates their gold content. There are, however, some glacio-fluviatile deposits that contain gold placers. These have resulted from the water sorting and transportation of material derived, often in very large bulk, from glacial scouring. The gold derived from glacial débris may be concentrated by stream or wave action. Glacio-fluviatile placers are likely to occur in gravel containing large boulders, the presence of which may increase the cost of mining. Some of the rich placers found in glaciated regions are concentrations that have been formed before glacial time and are remnants of ancient fluviatile deposits, which occur as buried channels.

Stream erosion and deposition constantly tend to a greater concentration of the heavy material, such as gold, and therefore the enrichment of any placers that are formed. This process goes on more or less through every physiographic cycle, and there is a continuous re-sorting of the alluvium. If, however, elevation renews active erosion, this process of re-sorting will be much accelerated. If placers already formed are then dissected and their gold content reconcentrated in a new placer, the deposit becomes a "re-sorted placer," which is usually far richer than one resulting from only a single epoch of erosion. Re-sorted placers may be formed by the dissection of old bench placers by streams or by wave action on old fluviatile placers on a coastal plain.

In considering the classification of the above table, it should be realized that many of the types merge into one another. Thus a residual placer may pass by insensible stages into an eluvial placer, which in turn will merge into a fluviatile placer. A region, as will be shown, may contain both fluviatile and glacio-fluviatile placers. It may also be difficult in any given locality to distinguish the placers due to one cycle of erosion from those which are re-sorted and therefore have resulted from two cycles.

Residual placers.—Though originally the formation of residual placers was probably very general, most of them have been swept away by subsequent erosion. Only a few small residual placers have been found in Alaska, and these have yielded but little gold.

Eluvial placers.—It has not been uncommon to find in Alaska deposits of loose rock containing a large amount of gold. This rock occurs in angular and subangular fragments derived by weathering of bedrock and accumulated by soil creep not far from its source. Running water has played no part in its sorting or deposition. An eluvial placer of extraordinary richness was mined in 1900 on the Caribou claim of Nekula Gulch, in the Nome district.[8] Another was discovered in 1906 on Coffee Creek, in the Kougarok district.[9] Such deposits are in the form of pockets and are of small linear extent. The "hill-slope placers," also eluvial, which occur on the bedrock underneath the talus of the valley walls, are due to talus creep resulting in local accumulations in irregularities of the bedrock surface. The concentration may have taken place in small irregular benches, as on Ophir Creek, on Seward Peninsula.[10] Examples of residual and eluvial placers are found in the Iditarod district, on the dome at the heads of Flat, Chicken, and Happy creeks.[11] Here the gold occurs in deeply weathered metallized granite and shows no evidence of sorting and transportation by running water. The richness of the placer appears to be due to heavy bedrock metallization. A similar deposit has been found on Hill Creek, in the Fairbanks district, where the placer gold rests directly on and within weathered granite, from the metallization of which it has been derived. The metallization, unlike that in the Iditarod district, was not strong enough to furnish rich placers, but the occurrence affords an example of eluvial placers in the Fairbanks district. In another section of this report Mr. Capps describes what is essentially an eluvial placer in the Yentna district.

Examples of rich eluvial placers formed since the region was glaciated have been found in southeastern Alaska. The first gold mined in the Juneau district, over 40 years ago, was found in deposits lying directly on or near the slope below the auriferous lodes that were later developed in the Alaska-Juneau, Perseverance, and Treadwell mines. In general, however, the time since the ice scouring has not been long enough to permit the weathering necessary to the formation of rich eluvial placers. As most of the Yukon basin and Seward Peninsula veins were never glaciated, one condition favoring the formation of eluvial placers is present. The placers of this type in Alaska that can be profitably mined by ordinary methods are but small. As they are located in valley slopes, the dredge can not be used for their exploitation. Such placers are believed to occur in many of the Yukon districts, such as Fairbanks, but the gold in them is so widely disseminated that it can not be mined except by methods permitting the economic handling of large quantities of talus material. It is believed that if water were available to hydraulic off the valley slopes of the gold-bearing areas of, say, the Fairbanks district, a large amount of gold could be recovered and a new epoch of placer mining would begin. Moreover, the clearing off of the

[8] Collier, A. J., The gold placers of parts of Seward Peninsula, Alaska: U. S. Geol. Survey Bull. 328, p. 200, 1908.

[9] Brooks, A. H., idem., p. 313.

[10] Collier, A. J., op. cit., fig. 14, p. 247.

[11] Mertie, J. B., jr., and Harrington, G. L., The Ruby-Kuskokwim region: U. S. Geol. Survey Bull. 754, pp. 114–115, 1924.

valley slopes would undoubtedly reveal gold lodes that are now hidden by the heavy talus. Without definite evidence that water for hydraulicking can be made available, however, it is visionary to speculate on such a project. Fairbanks lies in a semiarid region, in which stream gradients are low, and thus far no large hydraulic mining project has been undertaken there.

Fluviatile placers.—The descriptions of residual and eluvial placers show that they are formed by processes which are usually the first stages in the making of the placers that finally result from the sorting and transportation by running water. It should be noted, however, that the residual and eluvial stages may be almost entirely lacking, the gold being separated from the bedrock chiefly by abrasion, while weathering plays only a minor part. In such a deposit the concentration of gold may be effected entirely by the action of running water. Be that as it may, concentration and transportation by flowing water are the most potent factors in the formation of placers. Running water moves both coarse and fine material derived from erosion. The heavy particles, such as gold, are invariably concentrated at or near the bottom of the alluvial deposit, which is moving downstream. The effectiveness of stream transportation depends on the volume and grade of the stream, but in general it will not carry coarse gold more than 1 or 2 miles from its source, though the fine particles may be transported many miles. Experience has shown that the rich placers are confined to the surface of bedrock or at most to the lower 10 feet of the gravel resting on bedrock. Fine gold may occur throughout the gravel of the alluvium, though there is always a concentration in its lower part. "Bar placers" form a special type of fluviatile deposits which are concentrated on stream bottoms, many of them far above the bedrock. These placers are the result of eddies of the stream bottom interrupting the current and affording favorable sites for the deposition of fine gold. Bar placers are usually of small volume but are found in most placer districts.

The gold on Buck Bar, on the lower Stikine River, discovered in 1861, was the first to be profitably mined in Alaska. "Bar diggings" were also the first placers found in the upper Yukon basin, and some of these were rich enough to give profitable return to miners using rockers. Cassiar Bar, on Lewes River, was the most famous of these places, but others were mined on Hootalinqua, Salmon, Stewart, and other rivers. Bar placers had no economic significance except in giving support to the pioneer prospector. At present they serve to give a scanty living to the "sniper" and also to deceive the inexperienced gold seeker into the belief that bar placers are not simply a surface concentration but a sure evidence that richer placers will be found at depth. Many a dredging project has failed because the purely surface character of bar placers has not been recognized.

The fluviatile placers of the present streams are the commonest type and occur in every Alaska gold camp. They are usually shallow deposits and as such are cheaply exploited, but they do not include the richest of the Alaska placer deposits.

The placers formed by the ancient streams afford several types. These may occur in the valleys of the present streams, having been formed during a previous erosion cycle. The most easily recognized are those that occur on rock benches of the valley slope, which mark an older cycle of stream cutting and are of common occurrence in Alaska districts. The true bench placer is a different form of deposit, occurring in a rock-cut bench. By long usage placer-mining claims are called either "creek claims" or "bench claims." The creek claims are those located at and across the streams, and all parallel claims are called bench claims, irrespective of the type of placer they include. If the alluvial floor of the valley is wide one or more tiers of bench claims may be located in its bottom; if it is narrow claims may be staked on the valley slope where there is no bench, and the placer if present is properly a hillside placer of the type here classed as eluvial.

A true bench placer may also occur along the valley slope below the line of present filling. Such a placer will have no surface topographic expression and may be discovered only by excavation. This type of buried bench placer has been found, for example, on Livengood Creek, in the Tolovana district of the Yukon, and on Anvil Creek, at Nome.

Closely associated with these buried bench placers are the deep channel placers, such as those found in the Tolovana and Koyukuk districts and especially in the Fairbanks district. At Fairbanks the richest and most extensive placers occur as deep channels lying on the bedrock floor, in what were formerly broad valleys with gentle slopes.[12] This ancient topography has been obscured by valley filling, consisting largely of talus from the adjacent valley walls. The overburden consists largely of silt, which ranges in thickness from 30 feet or more near the heads of the valleys to over 200 feet toward their mouths. These placers were evidently formed under physical conditions different from those of the present day, and they are properly termed ancient. Most of the Fairbanks placers belong to this ancient type, though in the headwater regions of the creeks there are some normal present-stream placers.

Much searching for underground channels has been done in the Fairbanks district. While extension of those already known is probable, the finding of new ones is unlikely. It should be remembered, however, that the finding of deeply buried channels is a

[12] Prindle, L. M., and Katz, F. J., A geologic reconnaissance of the Fairbanks quadrangle: U. S. Geol. Survey Bull. 525, pp. 92–140, 1913.

laborious task, and in some of the Yukon camps the possibilities of this work are by no means exhausted. The deep channels of Seward Peninsula are chiefly those at Nome and are of marine origin. There is in the Kougarok district [13] a deep deposit of well-rounded gravel near Dahl Creek. Here a shaft was sunk in April, 1905, to a depth of 187 feet in well-rounded quartz gravel that contained a little gold, but as bedrock was not reached the presence or absence of a pay streak was not determined. This indicates that even some of the well-known placer districts of Alaska have not yet been thoroughly explored for deep channels.

A special type of buried channel occurs in the Fairhaven district of Seward Peninsula. Here the overburden consists of comparatively recently extruded lava flows. These lavas, in part at least, flowed over gravel that carries some placer gold. [14]

Bench placers have in places been formed by a drainage system that has little or no relation to the present valley arrangement. These were the result of an older system of erosion and deposition. Although they belong to a different physiographic cycle, they do not differ in essence from such deposits in the deep channels of Fairbanks or the bench placers in the valleys of many other districts. Their most significant feature is that dissection of them may furnish the gold for the enrichment of the more recent placers, which will be discussed under re-sorted placers.

The high bench placers of the Nome district are examples of these types that have been extensively mined.[15] These placers have been mined chiefly by expensive underground-drifting methods. Were water available to hydraulic the entire deposit, an additional large quantity of placer gold could be mined.

Some high bench gravel has been found in the Ruby-Kuskokwim region, but so far as known no workable placers have been found in it.[16] A deposit of high bench gravel has also been traced east of and along Minook Creek, in the Rampart district.[17] This gravel is, locally at least, gold-bearing, but in the absence of water at high level it has been but little mined. Other high bench gravels have been reported in Alaska but have not been described in detail. The White Channel of the Klondike, on the Canadian side of the boundary, represents this type of rich placer deposit.

[13] Brooks, A. H., The Kougarok region: U. S. Geol. Survey Bull. 328, p. 312, 1908.

[14] Moffit, F. H., The Fairhaven gold placers: U. S. Geol. Survey Bull. 247, pp. 31-35, 47-67, 1905.

[15] Collier, A. J., and others, The gold placers of parts of Seward Peninsula: U. S. Geol. Survey Bull. 328, pp. 198-209, 1908. Moffit, F. H., Geology of the Nome and Grand Central quadrangles: U. S. Geol. Survey. Bull. 533, pp. 101-108, 1913.

[16] Mertie, J. B., jr., and Harrington, G. L., The Ruby-Kuskokwim region: U. S. Geol. Survey Bull. 754, pp. 44-49, 1924.

[17] Hess, F. L., Placers of the Rampart region: U. S. Geol. Survey Bull. 337, pp. 64-98 1908. Eakin, H. M., A geologic reconnaissance of part of the Rampart quadrangle: U. S. Geol. Survey Bull. 535, pp. 31-32, 1913.

Beach placers.—The concentration of gold by wave action has taken place at many localities in Alaska. Most of the deposits thus formed are the result of a re-sorting of auriferous alluvium and therefore properly belong in what are here classed as re-sorted placers. The best-known and richest beach placers are those of Nome and Topkok, of Seward Peninsula.[18] At Nome the beach placers include both modern and ancient types.[19] The form of occurrence and genesis of the Nome beach placers have been fully described.[19a] The known beach placers of the peninsula are about mined out, though dredging ground at or near the ancient beach line still remains to be worked. At Topkok, where the only beach placers found are those of the present shore line, no beach placers have been found along the intermediate shore. Much prospecting has been done on the coastal plain at Solomon, but it has not disclosed an ancient beach,[20] though the search has by no means been exhaustive. Modern beach placers have been found at many places along the Pacific seaboard of Alaska. As early as 1891 beach placers were mined at Anchor Point, Cook Inlet, and they have since been mined at this and other localities of the vicinity.[21] A little beach gold was for many years mined on Popof Island, in southwestern Alaska,[22] and at several localities at the south end of Kodiak Island.[23] A little placer gold has been mined from the beach and south end of Middleton Island. About $200,000 worth of gold has been taken from the Yakataga beach placers during the 15 years of intensive mining.[24] A little beach gold has been won from the shore near Yakutat.[25] Valuable beach placers were long worked near Lituya Bay.[26] The total gold recovered from the Pacific coast beach deposits is from $500,000 to $1,000,000 in value. At none of these localities is there evidence of any reserves of placer gold, and at most of them the beach placers seem to be the result of wave cutting of material of glacial origin, in which the gold is undoubtedly widely disseminated.

---

[18] Collier, A. J., and others, The gold placers of parts of Seward Peninsula: U. S. Geol. Survey Bull. 328, pp. 151-165, 288-291, 1908.

[19] It is worthy of record that a geologic examination of the Nome region in 1899 led to the prediction of the discovery of ancient beach deposits in the coastal plain at Nome, which did not occur until several years later. Schrader, F. C., and Brooks, A. H., Preliminary report on the Cape Nome gold region, pp. 22-23, U. S. Geol. Survey Spec. Pub., 1900.

[19a] Moffit, F. H., Geology of the Nome and Grand Central quadrangles, Alaska: U. S. Geol. Survey Bull. 533, pp. 74-126, 1913.

[20] Smith, P. S., Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula: U. S. Geol. Survey Bull. 433, pp. 207-217, 1910.

[21] Martin, G. C., Geology and mineral resources of Kenai Peninsula: U. S. Geol. Survey Bull. 587, pp. 110-111, 1915.

[22] Atwood, W. W., Geology of parts of Alaska Peninsula: U. S. Geol. Survey Bull. 467, p. 125, 1911.

[23] Maddren, A. G., The beach placers of the west coast of Kodiak Island: U. S. Geol. Survey Bull. 692, pp. 299-319, 1919.

[24] Maddren, A. G., Mineral deposits of the Yakataga district: U. S. Geol Survey Bull. 592, pp. 134-143, 1914.

[25] Tarr, R. S., The Yakutat Bay region: U. S. Geol. Survey Prof. Paper 64, pp. 165, 168, 1909.

[26] Brooks, A. H., and others, Report on progress of investigations of mineral resources of Alaska in 1906: U. S. Geol. Survey Bull. 314, pp. 64-65, 1907.

Glacio-fluviatile placers.—It has been noted that glacial scouring dissipates the alluvial gold of a region and is unfavorable to the process of placer formation by weathering and stream sorting, described above. It is true, however, that glacial erosion removes a large quantity of material, and if this is sorted by fluviatile action, placers may be formed. Gold has been found in unsorted glacial débris, and the washing of such material by wave or stream action may form workable gold placers. The floods that accompanied the retreat of the ice were favorable to stream sorting of this kind. The glaciated parts of Alaska are likely to contain placers of three types—(1) ancient placers, formed before glaciation and by chance preserved from ice scouring; (2) glacio-fluviatile placers, which resulted from flooding during the disappearance of the ice sheets; (3) placers formed entirely in postglacial time.

The glacio-fluviatile deposits include all those in which the débris from which the placers were formed by fluviatile or marine action was originally scoured from bedrock by glaciers. Examples of these deposits are found in the beach placers of the Pacific seaboard, as well as in all the districts lying in the glaciated areas of Alaska, including the Juneau [27] and Porcupine [28] districts of southeastern Alaska, the Nizina district [29] of the Copper River region; Kenai Peninsula [30]; the Yentna district [31]; the Turnagain Arm region [32]; the Kantishna region [33]; and the Chistochina region.[34]

Re-sorted placers.—There are many placers whose gold content has been enriched by the erosion and concentration of the gold of older placers. The most easily recognizable of these are formed by the dissection of bench placers and the concentration of their gold content in modern stream placers. Such action has been observed in the formation of re-sorted placers by the dissection of the high bench placers of Nome. A similar process in the formation of re-sorted placers from auriferous bench gravels is observable in the Glenn Creek region of the Hot Springs district of the Yukon.

The present placers and some of the ancient beach placers of the Nome region are good examples of re-sorted placers, enriched by the dissection of older fluviatile placers. There are many other re-sorted placers, all characteristically enriched by the reworking of older placers.

---

[27] Spencer, A. C., The Juneau gold belt: U. S. Geol. Survey Bull. 287, pp. 77-85, 1906.

[28] Eakin, H. M., The Porcupine gold placer district: U. S. Geol. Survey Bull. 699, 1919.

[29] Moffit, F. H., and Capps, S. R., Geology and mineral resources of the Nizina district: U. S. Geol. Survey Bull. 448, pp. 98-108, 1911.

[30] Martin, G. C., and others, Geology and mineral resources of Kenai Peninsula: U. S. Geol. Survey Bull. 587, pp. 181-207, 1915.

[31] Capps, S. R., The Yentna district: U. S. Geol. Survey Bull. 534, pp. 47-72, 1913.

[32] Capps, S. R., The Turnagain-Knik region: U. S. Geol. Survey Bull. 642, pp. 174-187, 1916.

[33] Capps, S. R., The Kantishna region: U. S. Geol. Survey Bull. 687, pp. 76-98, 1919.

[34] Moffit, F. H., Headwater regions of Gulkana and Susitna rivers: U. S. Geol. Survey Bull. 498, p. 79, 1912.

PRODUCTION

A large part of the Alaska placer gold reserves are in the semiarid parts of the Territory, where the annual precipitation ranges from 10 to 20 inches. In many districts even a wet season may not supply water enough to sluice all the gravel that otherwise could be profitably mined. If the winter snowfall is light, the spring freshets may not suffice to wash the auriferous gravel accumulated by the deep winter mining. Again, if the summer rainfall is below normal, open-cut mining may lag, because streams do not furnish the water needed for sluicing. On the average, an extra dry period occurs about once in three to five years, and this always curtails gold production. During the period of bonanza gold placer discoveries and development the total placer output (p. 9) did not reflect the abnormal reductions in output of individual districts because of dry seasons, for these were usually more than offset by the increases from other camps. Now that the gold all comes from placers that have long been known, a curtailment by dry weather greatly reduces the total output. In the summer of 1923 abnormally dry weather persisted in Seward Peninsula and in many parts of the Yukon basin, notably in the Innoko, Ruby, Hot Springs, Fairbanks, and Circle districts, and also in the Yentna district of the Susitna basin. That the drought was not universal in the Yukon is shown by the heavy rains of midsummer in the Eagle and adjacent districts. The net result was a decline of $787,000 in 1923, as compared with 1922. Indeed, had it not been for the increase in dredging, the decline in placer-gold output would have been much greater. Even dredge mining has been hampered notably in Seward Peninsula by lack of water.

Under present economic conditions many of the Alaska placer mines are operated at a small margin of profit. There is therefore danger that such a disastrously dry year may have a far-reaching effect on the industry by finally discouraging the operators of many small mines. Should a still larger percentage of small-scale operators withdraw from the industry, the more normal annual output of gold will not be restored until more gold dredges are built or some other form of cheap mining is developed. The statistics of the placer-mining industry in 1923, as compared with 1922, are shown in the following table:

Statistics of placer mining in Alaska in 1922 and 1923

Region	Number of mines				Number of miners				Value of gold produced		
	Summer		Winter		Summer		Winter		1922	1923	Decrease or increase, 1923
	1922	1923	1922	1923	1922	1923	1922	1923			
Southeastern Alaska	2	5	1	----	3	12	2	----	3,000	3,500	+500
Copper River region	8	9	5	3	91	86	18	11	165,000	144,000	−21,000
Cook Inlet and Susitna region	36	35	1	----	174	180	2	----	293,000	247,000	−46,000
Yukon basin	321	301	99	64	1,254	1,078	321	243	2,119,000	1,644,000	−475,000
Kuskokwim region	30	28	----	2	137	106	----	4	542,000	292,000	−250,000
Seward Peninsula	104	60	11	6	528	606	51	29	1,265,000	1,270,000	+5,000
Kobuk region	6	8	3	----	11	13	8	----	8,000	8,000	--------
	507	446	120	75	2,198	2,081	402	287	4,395,000	3,608,500	−786,500

Gold dredge mining was very successful in 1923, in spite of the checks caused by the very dry season. Dredging has been done in Alaska for 20 years, during which a constantly growing percentage of the Alaska placer-gold output has been obtained from this form of mining, as is shown by the following table:

Relation of recovery of placer gold per cubic yard to proportion produced by dredges in Alaska, 1911–1923

Year	Percentage of placer gold produced by dredges	Recovery per cubic yard			Year	Percentage of placer gold produced by dredges	Recovery per cubic yard		
		Dredges	Mines	All placers			Dredges	Mines	All placers
1911	12	$0.60	$3.36	$2.17	1918	24	$0.57	$1.84	$1.20
1912	18	.65	2.68	1.70	1919	27	.77	1.31	1.10
1913	21	.54	3.11	1.57	1920	29	.69	1.53	1.13
1914	22	.53	2.07	1.26	1921	37	.57	1.31	.88
1915	22	.51	2.33	1.29	1922	40	.55	1.29	.84
1916	24	.69	2.64	1.57	1923	51	.40	1.28	.60
1917	26	.68	2.21	1.40					

As shown in the subjoined tables, there were 25 dredges operated in 1923, of which 16 were on Seward Peninsula, 7 in the Yukon basin, and 1 each in the upper Kuskokwim and Susitna basins.

Gold produced by dredge mining in Alaska, 1903–1923

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
1922	23	1,767,753	3,186,343	.55
1923	25	1,848,596	4,645,053	.40
	----------	26,723,801	----------	----------

The gold dredges operated in 1923 are listed below.

Seward Peninsula:
- Council district:
  - Northern Light Mining Co., Ophir Creek.
  - Wild Goose Mining & Trading Co. (2 dredges), Ophir Creek.
- Fairhaven district: Alaska Dredging Association, Candle Creek.
- Kougarok district:
  - Alaska Kougarok Co., Taylor Creek.
  - Behring Dredging Corporation, Kougarok River.
- Koyuk district: Dime Creek Dredging Co., Dime Creek.
- Nome district:
  - Bangor Dredging Co., Anvil Creek.
  - Center Creek Dredging Co., Snake River.
  - Dexter Creek Dredging Co., Dexter Creek.
  - Hammon Consolidated Gold Fields (2 dredges), various creeks.
  - Julien Dredging Co., Osborn Creek.
- Solomon district:
  - Eskimo Gold Mining Co., Solomon River.
  - Iversen & Johnson, Big Hurrah Creek.
  - Shovel Creek Dredging Co. (Nylen, Hultberg, and others), Shovel Creek.

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

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

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

The dredges were operated about 120 days in the Nome and Solomon districts and for shorter periods in other districts of Seward Peninsula. The dredges at Fairbanks and Iditarod had a season of about 110 days; at McGrath it was 176 days. Many of the dredges, for various reasons, were not operated the full time, but the above figures give an approximate measure of the length of the dredging season.

There was a notable increase of investigations of gold-dredging projects. With the long experience in Alaska dredging, there is no reason why haphazard projects should be undertaken. Reliable facts on the cost of transportation, which is decreasing, are now available. The drill affords a means of determining the quantity of the placer and its gold contents. Drilling will also determine the physical character of the deposit and, if frozen, its adaptability to thawing by the injection of cold water. If the deposit is in a glaciated region it will also determine whether the placer includes glacial erratics. There is good reason to believe that gold dredging will greatly increase in Alaska, but it is certain that projects of this kind will be successful only if they are fully investigated in advance of the installation of a machine.

COPPER

Copper ores are widely distributed in Alaska and have been profitably mined in the Ketchikan, southeastern Alaska, Chitina, Copper River basin, and Prince William Sound districts. Very promising deposits of copper have also been found in the headwater region of White and Tanana rivers, but these are too remote from transportation to justify present development. With the present low price of copper, even ores available to tidewater or railroad can not be profitably mined unless they are of high tenor or can be developed on a very large and hence economical scale. Accordingly there has been of late little search for copper deposits, and the development of many promising and accessible ore bodies has been discontinued. It appears that during 1923 little work was done on the many scattered copper prospects lying within 20 miles of the Alaska Railroad or the Copper River & Northwestern Railway. In spite of this stagnant condition of Alaska copper development, the output of copper was greater in 1923 than in 1922, as shown in the subjoined table. Most of it came from the Bonanza, Jumbo, and Mother Lode, three large mines of the Kennecott group, in the Chitina Valley, and the Beatson-Bonanza, on Prince William Sound, belonging to the same company. As for many years, copper was also produced at the Rush & Brown mine, in the Ketchikan district of southeastern Alaska, and small amounts from other properties under development. Special mention should be made of the properties visited by F. H. Moffit, who reports as follows:

Underground exploration of the Green Butte group, in the Chitina region, was vigorously pushed in 1923, and some ore was hauled over the wagon road to McCarthy and shipped over the railroad. The ore is chalcocite and copper carbonate, similar to that of the Kennecott mines, and occurs in the Chitistone limestone near the contact with the Nikolai greenstone. Developments thus far made reveal the occurrence of ore in three beds of the limestone, aggregating 16 feet in thickness. W. A. Dickey continued the development of his copper deposit at Rua Cove, Knight Island, on Prince William Sound. The total length of drift and crosscuts on this ore body is now about 1,800 feet, which is much greater than the length erroneously reported by the Geological Survey last year. This deposit occurs along a fault zone which traverses a complex of greenstone and cherty or quartzose rock, possibly altered sediments, and consists principally of pyrrhotite with some chalcopyrite. The mine workings make entrance on the seaward slope of a mountain which rises steeply to the north of Rua Cove. Here the outcrop is traceable to a height of 750 feet above the mine level. The fault zone has been traced north of the mountain crest for a distance of more than a mile and reveals the presence of copper minerals at a number of places.

The occurrences of copper on Prince William Sound are described by Mr. Moffit in another section of this volume.

Copper, silver, and gold produced at Alaska copper mines, 1880, 1900–1923

Year	Mines operated	Ore mined (tons)	Copper		Silver		Gold	Total value of metals
			Pounds	Value	Fine ounces	Value		
1880	1	20	3, 933	$826				$826
1900	1	500	100, 000	16, 000	200	$124	$500	16. 624
1901	2	1, 350	270, 000	44, 000	500	300	1, 100	45, 400
1902	3	2, 750	510, 000	59, 000	900	477	2, 600	62, 077
1903	4	9, 000	1, 730, 000	224, 510	2, 500	1, 350	10, 000	235, 860
1904	4	15, 000	2, 843, 586	376, 076	4, 000	2, 330	13, 000	391, 406
1905	8	52, 199	3, 481, 771	542, 155	30, 090	18, 292	35, 370	595, 817
1906	15	105, 739	6, 459, 803	1, 246, 682	27, 861	18, 577	80, 851	1, 346, 110
1907	13	98, 927	6, 308, 786	1, 261, 757	52, 056	34, 357	93, 858	1, 389, 972
1908	9	51, 509	4, 585, 362	605, 267	33, 602	17, 809	47, 483	670, 559
1909	7	34, 669	4, 124, 705	536, 211	22, 549	11, 726	41, 638	589, 575
1910	7	39, 365	4, 241, 689	538, 695	26, 388	14, 250	36, 484	589, 429
1911	8	68, 975	27, 267, 878	3, 408, 485	320, 114	169, 660	86, 569	3, 664, 714
1912	7	93, 452	29, 230, 491	4, 823, 031	376, 593	231, 605	153, 552	5, 208, 188
1913	6	135, 756	21, 659, 958	3, 357, 293	273, 179	165, 000	132, 000	3, 654, 293
1914	6	153, 605	21, 450, 628	2, 852, 934	283, 355	156, 695	171, 231	3, 180, 860
1915	14	369, 600	86, 509, 312	15, 139, 129	897, 839	455, 204	153, 121	15, 747, 454
1916	18	617, 264	119, 654, 839	29, 484, 291	1, 207, 121	794, 286	188, 977	30, 467, 554
1917	17	659, 957	88, 793, 400	24, 240, 598	1, 041, 153	857, 911	265, 900	25, 364, 409
1918	17	722, 047	69, 224, 951	17, 098, 563	719, 391	719, 391	107, 635	17, 925, 589
1919	8	492, 644	47, 220, 771	8, 783, 063	488, 034	546, 598	63, 795	9, 393, 456
1920	8	766, 095	70, 435, 363	12, 960, 106	682, 033	743, 416	18, 868	13, 722, 390
1921	6	477, 121	57, 011, 597	7, 354, 496	544, 311	544, 311	11, 689	7, 910, 496
1922	5	581, 384	77, 967, 819	10, 525, 655	623, 518	623, 518	15, 069	11, 164, 242
1923		731, 168	85, 920, 645	12, 630, 335	715, 040	586, 333	33, 633	13, 250, 301
		6, 280, 096	837, 007, 287	158, 109, 158	8, 372, 327	6, 713, 520	1, 764, 923	166, 587, 601

SILVER-LEAD

As already noted, some galena ore was mined and shipped in 1923 from two properties, the Red Top lode and the Alpha mine, in the Kantishna district, but these ventures proved unsuccessful because of the high cost of transportation to the smelter. Some ores, rich in silver and lead, were also shipped from the Hyder district, on Portland Canal, and, as before, both silver and lead were produced from the Juneau gold mines. Most of the Alaska silver output is a by-product of gold and copper mining.

Lead produced in Alaska, 1892–1923

Year	Tons	Value	Year	Tons	Value
1892	30	$2, 400	1909	69	$5, 934
1893	40	3, 040	1910	75	6, 600
1894	35	2, 310	1911	51	4, 590
1895	20	1, 320	1912	45	4, 050
1896	30	1, 800	1913	6	528
1897	30	2, 160	1914	28	1, 344
1898	30	2, 240	1915	437	41, 118
1899	35	3, 150	1916	820	113, 160
1900	40	3, 440	1917	852	146, 584
1901	40	3, 440	1918	564	80, 088
1902	30	2, 460	1919	687	72, 822
1903	30	2, 520	1920	875	140, 000
1904	30	2, 580	1921	759	68, 279
1905	30	2, 620	1922	377	41, 477
1906	30	3, 420	1923	410	57, 400
1907	30	3, 180			
1908	40	3, 360		6, 605	829, 414

TIN

There was no revival of tin mining in Alaska during 1923, in spite of the increased value of the metal. The only tin output of the year was that recovered incidentally to gold-placer mining in the Hot Springs district of the Yukon. This region is now accessible enough to lead to the hope that placer-tin mining might be justified. The heavy overburden makes prospecting for tin very difficult, and no bedrock source of the tin has yet been found. There was no tin mining in the York district of Seward Peninsula during 1923.

Tin produced in Alaska, 1902–1923

Year	Ore (tons)	Metal (tons)	Value	Year	Ore (tons)	Metal (tons)	Value
1902	25	15	$8,000	1914	157.5	104	$66,560
1903	41	25	14,000	1915	167	102	78,846
1904	23	14	8,000	1916	232	139	121,000
1905	10	6	4,000	1917	171	100	123,300
1906	57	34	38,640	1918	104.5	68	118,000
1907	37.5	22	16,752	1919	86	56	73,400
1908	42.5	25	15,180	1920	26	16	16,112
1909	19	11	7,638	1921	7	4	2,400
1910	16.5	10	8,335	1922	2.3	1.4	912
1911	92.5	61	52,798	1923	3	1.9	1,623
1912	194	130	119,600				
1913	98	50	44,103		1,612.3	995.3	939,199

PLATINUM METALS

Some 28 ounces of platinum and allied metals was recovered from gold placer mine concentrates obtained on Slate Creek, in the Chistochina district, Copper River region, and on Dime Creek, in the Koyuk district, Seward Peninsula. It was reported that small quantities of platinum occur in the placers of Alfred Creek, in the Nelchina region, and of Penny River, on Seward Peninsula. Since 1916 platinum metals have been recovered from placers only on Slate and Dime creeks, above mentioned, and on Boob Creek, in the Innoko district, and Bear Creek, in the Fairhaven district. Nowhere has placer platinum been found in sufficient quantities to make its recovery for itself alone profitable. Minute quantities of platinum are rather widely distributed in Alaska. The discovery of platinum deposits is very unlikely without a search specially directed toward this object.

The bedrock source of the alluvial platinum is not very definitely known. In general it is believed to have come from basic igneous rocks, which are usually dark green and have a high specific gravity. If such rocks are found, it will be advisable to examine the gravel derived from them carefully for traces of platinum.

The only known bedrock occurrence of the platinum and allied metals in Alaska is at the Salt Chuck mine, in southeastern Alaska. Here these metals occur in association with copper, in an ore body formed in basic igneous rocks.[35] Similar occurrences may be found elsewhere in the Ketchikan district. The Salt Chuck mine, containing palladium, platinum, and copper, was not operated during 1923 but will be reopened in 1924.

Platinum metals produced in Alaska, 1916–1923

Year	Crude ounces	Fine ounces	Value
1916	12.0	8.33	$700
1917	81.2	53.40	5,500
1918	301.0	284.00	36,600
1919	579.3	569.52	73,663
1920	1,493.4	1,478.97	160,117
1921	57.0	40.0	$2,670
1922	39.0	28.30	2,830
1923	37.0	25.90	3,004
	2,599.9	2,488.42	285,084

MISCELLANEOUS METALS

While war prices and demands prevailed for such metals as tungsten, antimony, chromite, molybdenite, and quicksilver, the search for and development of bodies of these ores was very active in Alaska. In 1923 this work, so far as reported, was entirely suspended, except that some residual scheelite (tungsten ore) was mined on Rock Creek, in the Nome district. A vein of scheelite, reported to be 5 inches wide, was discovered at the Apex-El Nido gold mine, in the Sitka district, during the year. The development of a bismuth-bearing lode in the Bonnifield district, south of Fairbanks, was continued.

In 1922 nickel was found on Snipe Bay, in the southern part of Baranof Island. This find, with the former discovery of nickel deposits on Chichagof and Yakobi islands, about 100 miles to the north, suggests that nickel may occur in a considerable zone and that a nickel-mining industry may be developed. (See a paper by A. F. Buddington elsewhere in this volume.) A little work was done at the Thrift mine and other quicksilver properties in the Iditarod-Kuskokwim region.

COAL

A new and valuable deposit of coal adjacent to the Alaska Railroad is described by S. R. Capps as follows:

This coal occurs in the Cantwell formation, which is widely distributed in the Alaska Range near the point where it is crossed by the railroad. The coal bed developed is itself of commercial value, and it is important to know that a new coal-bearing formation has been found near the railroad.

The McKinley Bituminous Coal Co. has this year opened a mine near the railroad track at mile 341. Here beds of coarse conglomerate, coarse sandstone, and shale cut by dikes and sills strike N. 70° E. and dip 70° N. A number of shallow excavations, now caved, show that the coal bed is continuous along the surface for about half a mile. At several places coal blossom shows at about 90 feet stratigraphically below the main bed, and there are other blossoms both

[35] Mertie, J. B., jr., Lode mining in Juneau and Ketchikan districts: [illegible]ey Bull. 714, pp. 121–125, 1921.

above and below this bed, so it is possible that there are other workable seams in the section. The bed that is being developed is paralleled on the hanging wall by a dark-colored igneous sill that averages about 30 feet in thickness and is separated from the coal by a thin shale, generally full of gouge, that is from an inch to 2½ feet thick. The footwall is a shale about 1 foot thick, overlying 3 to 4 feet of fairly hard coarse gray sandstone, which in turn overlies 80 to 90 feet of conglomerate. The intrusive sill makes an admirable hanging wall. Its lower surface rolls somewhat, but underground the dike is massive and little fractured and should stand with a minimum amount of timbering. The gouge in the hanging-wall shale shows repeated movements, in horizontal, vertical, and oblique directions.

The coal is bright, clean, and moderately fractured. The bed in the workings ranges from 5 to 6 feet in thickness. It is not a coking coal but appears to be of much better quality than any of the lignites of the Nenana field and to compare favorably with the best coal so far produced commercially from the Matanuska field. Locally the coal shows some evidence of coking from its close association with the overlying sill, but developments to date show only small areas so affected.

The mouth of the main entry is 1,200 feet west of and 300 feet vertically above the railroad at mile 341. It is now (August 17, 1923) 420 feet long, and there is a counter 380 feet long and 50 feet above the main entry. Chutes or raises are 50 feet apart. I estimate that there is now 7,000 to 8,000 tons of coal blocked out on four sides and ready to mine. An inclined tramway on a 14 per cent grade is being constructed from the mouth of the main entry to the railroad.

This is the first coal bed found on the north side of the Alaska Range that contains coal which is of high enough grade to be a good steam coal, and the mine should be able to supply the northern section of the railroad with steam coal, as well as develop a considerable market at Nenana and Fairbanks. The possibility is also suggested of good-grade coals being present elsewhere in the Cantwell formation. It is reported that in the course of further development work in this mine a fault was encountered that displaced the coal bed.

The following analyses of this coal have been made from samples supplied by the mine management. The analyses represent the coal as received.

Analyses of coal from Mount McKinley bituminous-coal mine

[By Bureau of Mines]

	1	2	3	4	5	6
Moisture	2.85	2.60	1.81	1.75	1.03	1.67
Volatile matter	24.08	23.76	24.05	25.35	25.18	25.42
Fixed carbon	63.77	61.38	58.55	57.87	53.76	61.18
Ash	9.30	12.26	15.59	15.03	20.03	11.73
	100.00	100.00	100.00	100.00	100.00	100.00
Calories	6,950	6,732	6,322	6,362	6,261	6,666
British thermal units	12,510	12,118	11,380	11,452	11,270	12,000
Sulphur	0.294	0.282	0.305	0.327	0.332	0.302

1. Bottom of bench counter.
2. Top of bench counter.
3. Full thickness of bench counter.
4. Full thickness of main gangway.
5. Top of bench main gangway.
6. Bottom of bench main gangway.

The surveys made in northern Alaska during 1923 under the direction of Sidney Paige[36] indicate that there is an area of at least 1,000 square miles underlain by coal between the Cape Lisburne coal field, long known, and Meade River, to the northeast. Most of this coal is too inaccessible to be available for present use. According to William T. Foran, a dozen beds of this coal, 4 to 10 feet wide, are well exposed on Kukpowruk River within 5 or 6 miles of the sea. These coal beds dip from 20° to 40°, are not faulted, and could easily be mined. The coal contains about 55 per cent of fixed carbon and is of about the same quality as the Corwin coal, on the Arctic, about 30 miles to the southwest. This coal could be brought down Kukpowruk River in shallow-draft barges and could be loaded on small vessels in the shelter of a lagoon at its mouth. The loading on small vessels would be better than at Corwin. This coal might find a market at Nome, which is now supplied by imported coal. The shipping season would, however, be limited to two or three months of the year. This coal would appear to be more accessible than the Corwin coal, of which 2,600 tons has been mined since 1880, chiefly by whalers.

Coal of the same quality has been mined on Wainwright Inlet, where the Alaska School Service has produced about 3,500 tons for the use of the neighboring native settlements.

Though some exploration of the high-grade coal of the Matanuska and Bering River fields was continued in 1923, it has not yet been proved that these fuels can be mined cheaply enough to find an export market, under present economic conditions. Meanwhile, evidence of the enormous reserves of lower-grade bituminous and lignitic coals in Alaska is accumulating each year. The use of Alaska coal for the needs of the Territory is expanding steadily. In 1923 a dozen small coal mines were operated in Alaska,[37] most of them on the Alaska Railroad, without which this coal would not be available.

[36] Paige, Sidney, and others, The Point Barrow region: U. S. Geol. Survey Bull. 772, 1925.

[37] The statistics of coal production in 1923 are furnished chiefly by B. D. Stewart, supervising engineer of the Bureau of Mines.

Coal produced and consumed in Alaska, 1880–1923

Year	Produced in Alaska, chiefly subbituminous and lignite		Imported from States, chiefly bituminous coal from Washington [a]	Total foreign coal, chiefly bituminous coal from British Columbia [a]	Total coal consumed
	Short tons	Value			
1880–1890	6,076	$37,205			
1891	1,083	6,291			
1892	871	5,093			
1893	923	5,372			
1894	488	2,765			
1895	1,687	9,290			
1896	712	4,142			
1897	2,673	31,393			
1898	2,652	27,201			
1899	2,264	22,836	10,000	[b] 50,120	62,384
1900	2,855	35,275	15,048	[b] 56,623	74,526
1901	2,740	29,843	24,000	[b] 77,674	104,414
1902	3,052	22,508	40,000	[b] 68,363	111,415
1903	2,717	21,302	64,626	[b] 60,605	127,948
1904	1,824	8,195	36,689	[b] 76,815	115,328
1905	4,334	15,070	67,713	[b] 72,612	144,659
1906	6,061	19,924	69,493	[b] 47,590	123,144
1907	10,689	55,770	46,246	[b] 93,262	150,197
1908	4,066	22,665	23,893	[b] 86,404	114,363
1909	3,430	16,350	33,112	69,046	105,588
1910	2,250	13,200	32,098	58,420	92,768
1911	1,850	11,690	32,255	61,845	95,950
1912	1,205	7,130	27,767	68,316	97,288
1913	2,312	13,290	69,066	56,430	127,808
1914	1,190	6,540	41,509	46,153	88,852
1915	1,629	6,653	46,329	29,457	77,415
1916	12,676	57,412	44,934	53,672	111,282
1917	54,275	268,438	58,116	56,589	168,980
1918	75,816	413,870	51,520	37,986	165,322
1919	60,894	345,617	57,166	48,708	166,768
1920	61,111	355,668	38,128	45,264	144,503
1921	76,817	496,394	24,278	33,776	134,871
1922	79,275	430,639	28,457	34,251	141,983
1923	119,826	755,469	34,082	43,205	197,113
	612,323	3,580,500	1,016,525	1,433,186	3,044,869

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

PETROLEUM

The only oil produced in Alaska in 1923 was obtained from a dozen small wells, one of which was drilled during the year on the single patented tract of petroleum land in Alaska, in the Katalla field. These wells are owned by the Chilkat Oil Co., which finds a ready local market for its product in the form of gasoline produced in its own refinery.

The search for oil has been continued in many parts of Alaska, but except in the Cold Bay field there has been no drilling in new fields during the year. Drilling was in progress during 1923 at the Pearl dome, 18 miles from the coast. Here the Associated Oil Co. sank two wells, about 500 feet (Finnegan claim) and 950 feet (Alaska Oil Co. claim) deep, but it suspended drilling in June. The Standard Oil Co., drilling on the same dome, reached a depth of 300 feet by August and is reported to have reached about 700 feet by November and 1,400 feet by March, 1924 (Lee claim). The company began the installation of a second drill in August (Lathrop claim). What is known of the geology and the results of the drilling still gives great encouragement to the finding of an oil pool on the Pearl dome. There are other structural features in the Cold Bay field that are favorable for oil, though the Pearl dome is believed to be the best one of which to make the first test.[38]

George C. Martin, who in 1923 hastily examined the Chignik region south of the Cold Bay field, reports that what he learned of the geology near Chignik is not favorable to the presence of petroleum. Kirtley Mather, who made a geologic survey of the northern part of the Alaska Peninsula, reports that some of the structural features and the formations are favorable to the presence of oil. A small seepage has long been known in the region near the mouth of Douglas River, which flows into Cook Inlet.

In 1923 Sidney Paige examined the oil seepages long known near Cape Simpson, about 50 miles southeast of Point Barrow, the northernmost point of Alaska. He reports[39] that there are two very large seepages emanating from small ridges about a mile apart and several miles from the coast. These are marked by flowing petroleum and cover many acres. There is a large accumulation of petroleum residue at these seepages. The surface exposures consist of clay shale with hard thin partings of calcareous shale, which lie nearly horizontal and are probably of Jurassic age. Mr. Paige and his two subparties explored a large area inland from the Arctic coast between Cape Beaufort on the south and Point Barrow and Cape Simpson on the north. He himself ascended Meade River for some 150 miles. These surveys indicate a wide distribution of what is believed to be the formation from which the Cape Simpson seepages emerge, which is probably of Jurassic age. These rocks are little disturbed near the north Arctic coast but are increasingly folded to the south, toward the mountains. No other seepages have been found, but what is known of the geology is not unfavorable to an oil field. This entire region lies in Naval Petroleum Reserve No. 4, and it was examined by the Geological Survey at the request and expense of the Department of the Navy.

[38] Smith, W. R., and Baker, A. A., The Cold Bay-Chignik district: U. S. Geol. Survey Bull. 755, pp. 151-218, 1924.

[39] Paige, Sidney, Foran, W. T., and Gilluly, James, The Point Barrow region, Alaska: U. S. Geol. Survey Bull. 772 (in press).

Petroleum products shipped to Alaska from other parts of the United States, 1905–1923, 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	83,992
1907	9,104,300	636,881	510,145	100,145
1908	11,891,375	939,424	566,598	94,542
1909	14,119,102	746,930	531,727	85,687
1910	19,143,091	788,154	620,972	104,512
1911	20,878,843	1,238,865	423,750	100,141
1912	15,523,555	2,736,739	672,176	154,565
1913	15,682,412	1,735,658	661,656	150,918
1914	18,601,384	2,878,723	731,146	191,876
1915	16,910,012	2,413,962	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	887,942	412,107
1921	9,209,102	1,403,683	2,021,033	232,784
1922	15,441,542	1,436,050	2,095,675	345,400
1923	12,285,808	4,882,015	473,826	454,090
	296,867,513	33,091,456	17,285,684	5,044,914

[a] Compiled from Monthly Summary of Foreign Commerce of the United States, 1905 to 1923, Bureau of Foreign and Domestic Commerce.

STRUCTURAL MATERIALS

The quarrying of marble began in southeastern Alaska in 1901 and has been an important industry since 1908. Most of the marble produced has come from the north end of Prince of Wales Island, where the only large Alaska quarries are located, but there are many other places in the Panhandle where marble has been found. The only commercial gypsum deposit found in Alaska is on the eastern shore of Chichagof Island, in the Sitka district. Here gypsum has been produced every year since 1906. The value of the total output of marble and gypsum to the end of 1923 is about $2,700,000. These industries were operated on about the same scale in 1923 as in 1922.

REVIEW BY DISTRICTS

SOUTHEASTERN ALASKA

The value of the total mine products of southeastern Alaska was $3,084,389 in 1922 and $2,356, 864 in 1923. The output of 1923 came very largely from five large and small gold and silver lode mines. Only one copper mine, the Rush & Brown, in the Ketchikan district, was operated throughout the year, but some copper was shipped from the Jumbo mine, in the same district. Shipments were also made from the Endicott mine at William Henry Bay, north of Juneau. In addition to the output of the lode mines, five small placer mines, a gypsum mine on Chichagof Island, and a group of large marble quarries near the north end of Prince of Wales Island were productive. The reduction in value of mineral output in 1923, as compared with the previous year, was largely due to the suspension of operations at the Chichagof gold mine in the Sitka district after July 1. The Alaska Juneau is now the only large mine in southeastern Alaska that has been continuously operated since it was first opened.

Production of Alaska Juneau mine, 1893–1923 [a]

Year	Ore (tons)			Metals recovered			
	Total	Fine milled	Coarse tailings rejected	Gold	Silver (ounces)	Lead (pounds)	Total value
1893–1913	507, 254	330, 278	176, 976	$707, 730	Lost in tailings		$707, 730
1914–1915	242, 328	239, 918	2, 410	251, 655	6, 192	117, 031	261, 326
1916	180, 113	180, 113		115, 022	2, 844	61, 068	121, 379
1917	677, 410	677, 410		429, 262	12, 248	296, 179	460, 666
1918	592, 218	574, 285	17, 933	430, 124	11, 828	273, 297	459, 445
1919	692, 895	616, 302	76, 593	499, 002	16, 431	359, 762	542, 714
1920	942, 870	637, 321	305, 549	732, 870	23, 348	487, 574	791, 390
1921	1, 613, 600	904, 323	709, 277	969, 703	40, 619	550, 913	1, 035, 251
1922	2, 310, 550	1, 108, 559	1, 201, 991	1, 296, 157	49, 404	687, 315	1, 388, 679
1923	2, 476, 240	1, 134, 759	1, 341, 481	1, 427, 199	41, 876	755, 423	1, 514, 774
	10, 335, 478	6, 403, 268	3, 832, 210	6, 858, 724	204, 790	3, 588, 562	7, 283, 354

[a] Compiled from published reports of mining company.

Some placer mining was done in the Silver Bow Basin, near Juneau, and a little beach mining at Yakataga. This work employed a total of 12 men. The most important gold and silver lode discoveries of the year were in the Hyder district, on Portland Canal, and on Chichagof and Admiralty islands. A new find of nickel on Snipe Bay, Baranof Island, indicates a probable southern extension of the nickel-bearing zone. These new discoveries are described by A. F. Buddington elsewhere in this volume.

COPPER RIVER BASIN

The only large operations in the Copper River region during 1923 were those of the three copper mines of the Kennecott group, already noted, as is also the continuation of the development of copper on the Green group of claims (p. 28). Work was continued at the Midas gold mine, in Chitina Valley. In 1923 mining was active in the Nizina and Chistochina placer districts and was continued in a small way in the Nelchina district. In this region a total of nine mines employing 86 men were operated and produced $144,000 worth of gold. In 1922 eight summer mines employing 91 men produced $165,000 worth of gold. In 1923 most of the gold produced came from three large hydraulic mines employing 75 men, which recovered on the average 81 cents' worth of gold to the cubic yard. These hydraulic mines were operated from 107 to 153 days.

PRINCE WILLIAM SOUND

In 1923, as in previous years, the only large mining operations on Prince William Sound were at the Beatson-Bonanza, on Latouche Island. Development was continued on the Rua Cove and other copper properties, as described by F. H. Moffit elsewhere in this volume. Some small operations were continued at the Tuscarora, near Valdez, the only productive gold lode mine on Prince William Sound during the year.

KENAI PENINSULA

In the summer of 1923 some 10 placer mines employing 55 men were operated on Kenai Peninsula and produced $38,000 worth of gold. The same district in 1922 contained 14 active placer mines employing 51 men and produced $40,000 worth of gold. The largest mines are those equipped with hydraulic plants on Crow, Canyon, Lynx, and Resurrection creeks, where the average recovery was about 30 cents to the cubic yard. Because of the very dry season most of these mines were operated less than 100 days. One coal mine was operated at Bluff Point, on Cook Inlet.

The following notes by S. R. Capps summarize the conditions of lode mining on Kenai Peninsula in the summer of 1923:

The Kenai Star mine, in the Palmer Creek basin, milled 80 tons of ore in the early part of the summer. The mill returns being unsatisfactory, the crew was put to prospecting for better ore and building an inclined track for hauling ore from the main tunnel to the crusher at the mill. It is reported that later in the summer the directors decided to close the mine. The mill was sold to the Lucky Strike mine, and plans were under way to remove it and reinstall it on the Lucky Strike this fall.

The Robin Red Breast prospect, of J. Kacerosky and H. W. Hargood, 800 feet east of the Kenai Star, has a tunnel 90 feet long on one level and another 54 feet long on another level. The owners are reported to have a large body of ore that assays well in gold. This ore body is 250 feet from an acidic dike that itself assays in gold. The same two men have a 5-foot prospect tunnel on the adjoining Esther claim, which is said to show a 2-foot quartz vein that carries sulphides and assays well in gold.

The Lucky Strike mine, of the Alaska Minerals Co., generally known as the Hershey mine, has developed an ore body which is a stockwork of thin quartz veins in slate, the ore zone ranging in width from practically nothing to 4 feet or more. The quartz is somewhat rusty and carries besides free gold arsenopyrite, pyrite, galena, and a little chalcopyrite. The relationship of quartz veins to acidic dikes is not shown in the mine, though such dikes crop out on the surface not far away, and the veins are almost certainly genetically related to them. The mine has approximately 800 feet of underground workings in three tunnels and crosscuts from them, in addition to about 100 feet of slopes. The present mill, a Gibson eccentric grinder, with a capacity of 3 tons in 24 hours, is to be enlarged this fall by the installation of a Hendy mill, of five 1,000-pound stamps, purchased from the defunct Kenai Star Co.

A. O. Robinson and C. P. Bowman have driven a 220-foot prospect tunnel into the east wall of the Palmer Creek canyon. The country rock, of slate and graywacke, strikes about north and dips 60° E. The tunnel is run on a streak of clayey gouge containing some quartz that cuts the slate and graywacke at a slight angle. An acidic dike in the slate and graywacke appears on the mountain above the tunnel, and the vein is thought to be genetically related to this dike. The quartz contains pyrite, arsenopyrite, galena, and locally free gold. The gold along the vein underground is of erratic distribution, and no body of pay ore had been uncovered when the examination was made.

SOUTHWESTERN ALASKA

The most important development in southwestern Alaska in 1923 was the drilling for oil on Cold Bay (p. 34). Probably a little beach placer mining was continued on the south end of Kodiak Island, but no report of it was received. A little alluvial gold has been found near Cape Kubugakli, as described by W. R. Smith elsewhere in this volume. This is the only place on Alaska Peninsula that placers have been mined. Some work was continued during the year on the McNeil copper property, described in another part of this volume by Kirtley Mather. Nothing new appears to have been found in the copper district of Iliamna Lake.

SUSITNA-MATANUSKA REGION

Productive mining in the Susitna-Matanuska region includes that of gold lodes in the Willow Creek district, placer mining in the Yentna and Valdez Creek districts, and coal in the Matanuska district. The total value of the mineral output in this region was $803,685 in 1922 and $955,062 in 1923.

WILLOW CREEK DISTRICT

By S. R. Capps

In addition to the six gold lode mines productively operated in the Willow Creek district during 1923, considerable search was made for ore bodies. The following notes on this work are not complete, being the hasty observations of a few days' visit, made in the fall of the year.

The old Gold Cord mine, on the C. B. Smith property, is at the head of the Fishhook Creek basin. This year arrangements were made to prospect this vein by a new management, under a five-year lease. The new company installed a 15-horsepower gas engine, compressor, and tool sharpener, also a 3-horsepower gas engine and ventilating fan and an assay shop. The main adit tunnel has been driven 575 feet. The lode includes irregular bunches that pinch and swell irregularly and is faulted along many planes, with a gouge. An open cut indicates another vein farther north that carries considerable chalcopyrite. At the time of visit no considerable body of milling ore had been blocked out. While this mine was leased to the Alaska Free Gold Mine Co. 1,600 tons of ore was mined and milled on Gold Creek, and from it $21,000 in gold was recovered.

Eleven tons of this ore milled separately yielded $225 in gold to the ton.

The Kelly Mines Co., whose property includes the old Independence, Alaska Free Gold, and Independence mines, milled no ore in 1922 or 1923. Everything on the Fishhook Creek side of the mountain was shut down at the time of visit, and operations centered on the Willow Creek side of the divide, where the main effort was directed to the running of a long adit tunnel to cut at depth the veins previously mined on the Fishhook Creek side. This adit was then in 975 feet and had cut several quartz veins that the manager believed he identified as those for which the tunnel was driven. The first vein, thought to be the Skyscraper vein, was cut at 760 feet from the portal. In a 30-foot drift along the vein it shows a few inches of quartz and gouge vein matter. At 850 feet from the portal what is identified as the Skyscraper vein was cut, and a 30-foot drift to the north on it shows a maximum of 9 inches of quartz but commonly much less. At 965 feet from the portal the tunnel cuts what is thought to be the Blacksmith Shop vein, which shows a maximum of over a foot of quartz and vein matter. These veins all strike about N. 10° W. and dip 30°–40° W. The meager gold content and the small size of the veins where cut by the adit tunnel are disappointing, but exploratory work along the veins is expected to show the usual swellings in the veins and to reveal minable ore shoots. Several faults were encountered in the adit tunnel, the amount of displacement of which has not yet been determined. The mine on the Willow Creek side is equipped with a 15-horsepower gas engine, a compressor, a 4-horsepower gas engine and ventilating fan, a hoist for steel from the blacksmith shop to the tunnel mouth, and three machine drills.

The Gold Bullion, Lucky Shot, and War Baby mines belong to the the Willow Creek Mines Co.[40] and are on Craigie Creek. The Gold Bullion was worked all winter. The mill started early in June and shut down on July 8 for the rest of the year. Ore was taken from No. 5 tunnel. There is a rich lode showing on the Willow Creek side of the divide, which is believed to be the outcrop there of the Bullion vein. The company intends sometime to drive through to cut this vein from the Bullion workings.

At the Lucky Shot mine during the winter 4 men worked in the upper (Hogan) level, and 11 men in the lower adit tunnel, which is 300 feet vertically below the Hogan level. The adit is 825 feet long, and at the breast the Lucky Shot vein was intersected. The lode there is 3 to 4 feet wide, including quartz and also vein matter. The quartz occurs in shoots as much as 3 feet wide. The Lucky Shot and War Baby mines are now worked as parts of the same mine, and the ore from both is taken to the Lucky Shot mill. In the Lucky Shot

[40] See U. S. Geol. Survey Bull. 607, pl. 3, 1915, and Bull. 712, fig. 5, p. 170, 1920.

mine development work has been carried out on three levels. The upper or 100-foot level has 50 feet of adit and 200 feet of drifts, the Hogan or 200-foot level 250 feet of adit and 600 feet of drifts, and the lower or 500-foot level 825 feet of adit and 150 feet of drifts. In addition there are considerable areas of stoped ground. The War Baby mine has 685 feet of adit and 200 feet of drifts on the lower (700-foot) level, 50 feet of adit and 80 feet of drifts on the second level, and 100 feet of adit on the upper level. A prominent fault, with a displacement of about 400 feet, lies between the adjoining Lucky Shot and War Baby claims. The new Lucky Shot adit encountered the vein mined above at about the calculated position, but on this lower level the ground is tighter and the vein is smaller than was expected. No good ore has yet been disclosed in these lower workings. In all the workings of these mines there is much evidence of movement along all the veins, with development of abundant gouge. In places the vein matter is largely crushed diorite and gouge, with little or no quartz. The diorite wall rock shows little mineralization.

Lee John, John Johnson, and E. Johnson have started to drive a crosscut tunnel on Shorty Creek, to tap what is supposed to be the extension of the Lucky Shot-War Baby vein.

The "Jap mine," operated by Hari Yago, is on upper Willow Creek, on the southeast slope of Bullion Hill. The property is developed by four adits 400, 100, 25, and 30 feet long. The veins revealed range from a few inches to 18 inches in width. No attempt was made to mine ore carrying less than $100 a ton in free gold. The property is equipped with a 1-stamp prospecting mill having a capacity of 200 pounds in 13 hours and an arrastre (now broken down), both operated by water power from Willow Creek.

The Gold Mint mine, on Little Susitna River, was closed in 1923.

At the Mabel mine, on Archangel Creek, 400 to 500 feet of new workings, mainly to the south along the vein, have been driven. Mining this year has consisted mainly of cleaning up ore from old workings, but some ore has been taken from the new south excavations. The mill was started June 3. The vein shows the same characteristics as heretofore, swelling from a thin seam to 6 feet of quartz within short distances. The workings have disclosed several faults of a few feet to 50 feet displacement. The material mined ranges from vein matter below mill grade to very high-grade ore. The present management is attempting to develop tonnage for future milling. Only one shift is worked in the mine and mill. A Denver Chile mill, operated by water power, and a gas engine and compressor are at the mine. The management contemplates moving the cable tramway from the gulch to a spur to the north, to avoid trouble with snow during winter operations.

The property of the Consolidated Gold Mines (formerly Matanuska Gold Mining Co.) is on Fairangel Creek. The main workings are at the old mine, where some rich ore is reported at the bottom of a 30-foot winze in the main tunnel. The mine has one vein 30 inches wide and another 16 inches wide. The company is contemplating putting in new machinery and driving a 500-foot tunnel, just back of the mill, to cut old ore bodies at depth. The old tunnel is now in about 500 feet and is expected at any time to cut a lode that crops out above it. On the Alaska-Willow Creek claim of this company, which is on the mountain slope east of Reed Creek, opposite the Mabel mine, an adit has been driven for 140 feet with the hope of striking a quartz vein that is exposed on the surface 240 feet above the tunnel, but it had not reached the vein at the time of visit. This company has made a new find on Craigie Creek, on the old Miller-Newman claims, which are reported to have an open cut 60 feet long on a vein showing from 4 to 10 inches of very rich quartz. The company is prospecting for the extension of this vein, with the purpose of running a tunnel to cut the ore body that is exposed on the surface but is now inaccessible.

The Fern Gold Mining Co.'s property is on the east spur of the mountain between Fairangel and Archangel creeks. The mine and mill operated last winter and until late in June, since when the mill has not been operated. The No. 1 adit is now in 700 feet, with 50 feet of crosscuts. The No. 2 adit, 180 feet below, was at the time of visit 245 feet long, and the company hopes to cut the ore body at about 550 feet from the entrance. Only development work is being done at present. The mine is equipped with a Denver Chile mill, a 25-horsepower semi-Diesel engine, and a cable tramway from the mine to the mill.

The Opal prospect, owned by Dave Skarstad and Leonard Laubner, includes four claims surveyed for patent last year. The main adit is in 200 feet, with 100 feet of drifts. At the breast of the main adit the vein, exposed on the surface above, was cut, showing a maximum of 2 feet of quartz. It contains free gold, and the tenor is said to be high in places. It shows some faulting, and the vein zone contains much gouge. Another vein, encountered at 52 feet from the portal, shows 14 inches of vein matter and 4 to 5 inches of quartz, but the tenor is low.

The Homebuilder prospect on Reed Creek is being explored by Paul Hanson and Ernest Richter. On this prospect a series of open cuts show a vein zone as much as 5 feet wide, which contains quartz and mixed vein material. The quartz shows considerable pyrite and is said to yield good gold prospects by panning. The vein strikes N. 70° E. and dips 35° NW. A projected 600-foot adit tunnel, now in 140 feet, it is hoped will cut the vein 300 feet below the surface workings.

Mike Sherry has a prospect on the west side of the Reed Creek valley about a mile north of the Homebuilder. He is reported to have an adit in 120 feet, of which 30 feet was driven this year. This adit is said to show a small quartz vein at the face.

Gold and silver produced at lode mines in the Willow Creek district, 1908–1923

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	957.00
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
1922	7	7,242	11,513.25	238,000	1,500.00	1,500.00
1923	6	9,132	8,622.29	178,238	912.00	748.00
	------	86,018	114,612.43	2,363,235	10,287.27	8,048.98

PLACER MINING IN THE YENTNA DISTRICT

In 1923 21 summer mines employing 98 men were operated in the Yentna district and produced $189,000 worth of gold. An output of $223,000 worth of placer gold was made in 1922. The decrease is entirely due to the lack of water, which seriously hampered all hydraulic mining and even curtailed dredging on Cache Creek, the largest operation on that stream. The principal mining operations included one dredge and eight hydraulic plants; the other mines were worked with pick and shovel. It is estimated that a total of 398,000 cubic yards of gravel was sluiced, yielding an average of 47 cents' worth of gold to the cubic yard. A description of a Tertiary placer in the district is given by Mr. Capps on pages 53–61.

MISCELLANEOUS MINING IN THE REGION

About half a dozen placer mines were operated in the Susitna region besides those of the Yentna district. Some coal was mined at a few localities in the Matanuska field; the Evan Jones mine was operated throughout the year. A new copper (chalcopyrite) bearing lode was reported 10 miles east of Matanuska station. In August, 1922, Arthur Moose Johnson discovered an ore body carrying ruby silver about 10 miles east of Chulitna, a station on the Alaska Railroad. This deposit is in a region geologically unsurveyed, but the ore is said to be associated with igneous dikes. The ore body is reported to be large, and the assays made by the Bureau of Mines from the samples submitted by the owner showed a high silver content and some gold. The property, called the Mint, is on Portage Creek and is the first one reported from Alaska carrying ruby silver.

YUKON BASIN

GENERAL FEATURES

The first gold placers to be mined in the Alaska Yukon were those on Fortymile River in 1886. Alluvial gold mining has ever since been the dominating industry of the Yukon. Since 1903 some gold-lode mining has been done in the Fairbanks district, and since the building of the Alaska Railroad some coal has been mined in the Nenana field. The only other mining in the Alaska Yukon was a small production of lead, silver, copper, tin, tungsten, antimony, and platinum. The total mineral output is as follows:

Mineral production of the Yukon basin, Alaska, 1886–1923

	Placer mines		Lode mines		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
Gold ....fine ounces..	6,577,870	$135,975,000	66,923	$1,382,934	6,644,793	$137,357,934
Silver ....do....	1,120,256	691,199	264,055	262,886	1,384,311	954,085
Coal ....tons..	....	....	....	....	116,561	594,295
Lead, copper, tin, antimony, tungsten, and platinum..........	....	....	....	....	....	549,880
	....	136,666,199	....	1,645,820	....	139,456,194

In 1923 there were 301 summer and 64 winter placer mines, 3 gold lode mines (Fairbanks district), 2 silver-lead deposits (Kantishna district), 3 placer mines producing some tin (Hot Springs district), and 2 coal mines (Nenana field) that were productive in the Alaska Yukon. The total value of their output is as follows:

Mineral production of the Yukon basin, Alaska, in 1923

	Placer mines		Lode mines		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
Gold ....fine ounces..	79,528	$1,644,000	1,250	$25,844	80,778	$1,669,844
Silver ....do....	11,106	9,106	17,194	14,099	28,300	23,205
Coal, lead, copper, and tin..........	....	....	....	....	....	182,547
	....	1,653,106	....	39,943	....	1,875,596

GOLD PLACERS

As shown by the subjoined table, placer mining greatly decreased in 1923 compared with 1922, in part because of the exhaustion of the rich deposits on which most of the Yukon districts have largely depended to maintain their gold output, but mainly because of the exceptional dryness of the season, which cut down the stream flow so greatly as to produce a shortage of water for sluicing. This dearth of water was notable in the Fairbanks, Rampart, Circle, Richardson, Ruby, Innoko, Iditarod, and Koyukuk districts. Indeed, the aridity persisted over all the Yukon basin, except in the Eagle and Fortymile districts. In the Seventymile Valley of the Eagle district unusual floods wrecked much of the mining equipment. In most of the Yukon districts there is a great need for wagon roads, which will lower the cost of transportation and therefore of mining. The search for placers suitable for dredging is being extended to nearly all the Yukon districts. In 1923 two dredges were operated in the Fairbanks district, two in Innoko, two in Iditarod, and one in Circle.

Placer gold produced in Yukon basin, 1922 and 1923, by districts

District	Value of gold		Summer				Winter			
			Mines		Miners		Mines		Miners	
	1922	1923	1922	1923	1922	1923	1922	1923	1922	1923
Fairbanks	$693,000	$603,000	62	62	392	313	27	21	108	115
Iditarod	280,000	228,000	14	20	126	118	1	-----	10	-----
Tolovana	221,000	164,000	26	18	132	76	12	8	61	45
Innoko (including Tolstoi district)	224,000	153,000	18	21	62	75	4	2	6	8
Circle	121,000	114,000	15	18	42	64	8	6	16	8
Ruby	123,000	72,000	24	28	67	80	13	4	39	8
Hot Springs	55,000	62,000	25	17	61	53	3	1	9	2
Fortymile	50,000	53,000	24	28	52	59	18	14	33	25
Chandalar	83,000	42,000	4	4	15	7	1	2	10	12
Koyukuk (including Indian River district)	132,000	37,000	36	16	106	33	10	4	25	17
Chisana	29,000	23,000	9	9	25	22	-----	-----	-----	-----
Eagle	24,000	23,000	14	11	28	35	-----	-----	-----	-----
Rampart (including Gold Hill district)	18,000	16,000	14	6	25	14	2	2	4	3
Richardson (Salcha-Tenderfoot)	2,000	16,000	3	5	6	41	-----	-----	-----	-----
Bonnifield	10,000	13,000	7	13	24	41	-----	-----	-----	-----
Kantishna	32,000	13,000	14	13	60	19	-----	-----	-----	-----
Marshall	22,000	12,000	12	12	31	28	-----	-----	-----	-----
	2,119,000	1,644,000	321	301	1,254	1,078	99	64	321	243

About 2,000,000 cubic yards of gravel was sluiced in the Yukon districts during 1923, and the average value of gold recovered was 82 cents to the cubic yard. The first gold was mined at Fairbanks in 1903. The total output since then, by creeks, is as follows:

Approximate distribution of placer gold produced in Fairbanks district, 1903–1923, by sources

Cleary Creek and tributaries	$23,252,000
Goldstream Creek and tributaries	15,286,000
Ester and adjacent creeks	11,497,000
Dome and Fairbanks creeks	16,711,000
Vault Creek and tributaries	2,733,000
Little Eldorado Creek	2,380,000
All other creeks	717,000
	72,576,000

Most of the placer gold produced at Fairbanks during the summer was mined by two dredges, 21 drifting operations, 10 steam scrapers, and 12 small hydraulic plants. The 62 summer mines and the 21 winter drift mines excavated about 524,000 cubic yards of gravel that was sent through the sluice boxes, which averaged about $1.15 worth of gold to the yard.

The second largest producer of the Yukon basin was the Iditarod district, where the largest output came from the two dredges, which with nine hydraulic plants, one steam scraper, and two open-cut mines excavated about 624,000 cubic yards of gravel, which averaged 37 cents in gold to the yard. In the Tolovana district seven summer drift mines, five hydraulic mines, and eight winter drift mines worked 59,000 cubic yards of gravel, yielding an average of $2.77 of gold to the cubic yard. The placer-mine production and the number of plants operated in the smaller Yukon districts are presented in the table on page 45.

LODE MINING

During 1923 there was no important advance in the discovery or development of lode deposits in the Yukon basin. As already shown (p. 13), only three auriferous lodes were productive, and these in only a small way, at Fairbanks. There was some systematic prospecting of the auriferous quartz veins in the Iditarod district. Work was continued on the Arnold quartz claim, in the Marshall district.

KUSKOKWIM BASIN

Kuskokwim River, second in size of Alaska streams, drains a vast area between the mountains bordering the Pacific and the Yukon Valley. Its drainage basin is estimated to include over 50,000 square miles, less than a third of which has been surveyed. The Kuskokwim basin, though off the main route of travel, is not difficult of access. Small ocean vessels may enter the mouth of the river and run up to Bethel, 50 miles from the sea, and thence the journey may be continued up the river by steamers at least as far as Berry's Landing, a distance of about 400 miles from tidewater. Some of the southern tributaries are also in part navigable for small boats. Three small river steamers give communication with Bethel, where the ocean boats deliver their cargo.

McGrath, the largest settlement on the upper river, may be reached by winter trail from Ruby, on the Yukon, a distance of about 170 miles. This trail is now being made into a wagon road, of which about 70 miles is completed. Formerly mail was carried to McGrath either from the mouth of the river in summer and by dog team from Fairbanks, by way of Lake Minchumina, in winter or from Seward by way of Rainy Pass. Now the mail is brought by airplane from Nenana, on the railroad. The radio station keeps McGrath in constant communication with the outside world.

The earlier visitors to the Kuskokwim basin were attracted by the fur hunt, which continues to be an important industry. There are considerable areas of arable and grazing lands in the upper Kuskokwin basin, and potatoes and other hardy vegetables may in favorable seasons be raised along the river nearly to its mouth. There are also large areas of reindeer pastures within the Kuskokwim basin. Much salmon is preserved for local food along the lower course of the Kuskokwim.

Some quicksilver-carrying lodes were the first mineral deposits of the Kuskokwim to attract attention. They were known as early as 1880 and were explored prior to 1898. The Parks quicksilver prospect, near Kolmakof, on Kuskokwim River, about 15 miles above Georgetown, was discovered in 1906, and between that date and 1914 it produced about 700 pounds of the metal.[41] Later better reducing equipment was installed, and developments have continued in a small way up to the present time. There appears to have been a small output of quicksilver, which found a market in Alaska placer-mining camps until 1921. An extension of the mineralized zone was made evident by the opening of a quicksilver deposit on Montana Creek, a tributary of Iditarod River,[42] about 40 miles northwest of the Parks property, where some quicksilver was produced.

Placer gold was first found in this region in the Goodnews Bay district, adjacent to Kuskokwim Bay, in 1900, and during the next six years the prospector extended his search northward, gradually disclosing a not very well defined auriferous zone, which includes the Goodnews Bay, Tuluksak-Aniak, Georgetown, and McGrath (McKinley) districts. This zone crosses Kuskokwim River at Georgetown and north of that merges into a gold-bearing zone of the Iditarod, Innoko, and Ruby districts. As in other parts of Alaska, this auriferous zone is marked by a line of intrusions. In 1917 another locus of intrusion was found near a granite contact, in the headwater region of Nixon Fork, a tributary of Takotna River, which joins the Kuskokwim at McGrath. The granite of Nixon Fork is a small area, but its axis of intrusion seems to be marked by another granite stock which is 15 miles to the north. The extension of this axis of intrusion to the southwest goes into an unmapped area. Seventy miles to the east lies the field of intrusion following the crest line of the Alaska Range, along the margin of which some metallized rock has been found. The above outline of the distribution of gold shows a broken yet well-marked axis of granite intrusion extending through the heart of the Kuskokwim basin; another one, 50 miles to the east, has been traced only a short distance.

---

[41] Smith, P. S., and Maddren, A. G., The quicksilver deposits of the Kuskokwim region; U. S. Geol. Survey Bull. 622, p. 274, 1915.

[42] Brooks, A. H., The Alaska mining industry in 1921: U. S. Geol. Survey Bull. 739, p. 13, 1923.

It has thus far been impossible to obtain accurate statistics of mineral production and mining operations in the Kuskokwim region. The incomplete returns from mining operations have been supplemented by estimates made on the best information available in compiling the following table, the errors in which must be charged to those miners who have failed to furnish the information requested each year.

Estimated value of placer gold produced in the Kuskokwim region, 1908–1923

Year	Number of mines	Number of men	Value of gold	Year	Number of mines	Number of men	Value of gold
1908			$3,000	1917	23	78	$100,000
1909			5,000	1918	19	87	100,000
1910			15,000	1919	22	104	350,000
1911			25,000	1920	32	125	305,000
1912			35,000	1921	31	106	520,000
1913	16	50	50,000	1922	30	137	542,000
1914	25	80	100,000	1923	30	110	292,000
1915	25	80	100,000				
1916	20	70	80,000				2,622,000

The first placer gold reported from the region was that mined in 1908, though there was probably some output in earlier years. Most of the output in the first years of known production came from the Goodnews Bay and Tuluksak-Aniak districts; later the annual output was greatly swelled by contributions from the camps farther north, notably from the McGrath district, where rich placers were opened up on Candle Creek. In 1917 a dredge was installed on these deposits, and in the last few years it has been operated very successfully. This and other mining on Candle Creek has placed the district in the front ranks of Alaska placer producers. The searching out of dredging ground is not the most important event in the Kuskokwim placer district. In 1917 a rich gold lode (Crystal) was discovered in the Nixon Fork district, near which a few placer mines had been developed. The ore occurs in limestone near the margin of a granite stock.[43] This property was subsequently taken over by the Treadwell Yukon Co. (Ltd.) and developed as the Nixon Fork mine. Some ore was shipped down Kuskokwim River, 12 miles distant. A 10-stamp mill was installed in 1921 and was operated in 1922 and 1923.

The Nixon ore contains, besides gold and silver, about 2 per cent of copper. A copper deposit occurs in the Russian Mountains, west of the lower Kuskokwim, lying along a margin of a granite intrusion.[44] This ore contains chalcopyrite and arsenopyrite. A stibnite and gold bearing vein has been found in the same mountains. Stibnite also occurs in association with the quicksilver deposits of the lower

[43] Martin, G. C., Gold lodes in the upper Kuskokwim region: U. S. Geol. Survey Bull. 722, pp. 146-161, 1922.

[44] Maddren, A. G., Gold placers of the lower Kuskokwim: U. S. Geol. Survey Bull. 622, p. 359, 1915.

Kuskokwim Valley, already referred to, and realgar-bearing lodes have been found in the same area and elsewhere in the Kuskokwim region. Small areas of coal land are widely distributed in the Kuskokwim basin. Some of the coal is of high bituminous grade, and much of it is lignitic. An extensive coal field is reported in the basin of Big River, a tributary of the South Fork of the Kuskokwim. The very fragmentary information given above is included because it comes from many reports of the Geological Survey.

SEWARD PENINSULA

The most important event of the year in Seward Peninsula was the launching at Nome early in June of the two great gold dredges of the Hammon Consolidated Gold Fields. These machines are 115 and 140 feet in length, with digging ladders over 70 feet long, and are equipped with buckets of 9 cubic feet capacity. Their successful operation for a year marks a new epoch in Alaska dredge mining.

It has long been known that the coastal plain, at places stretching inland a distance of over 4 miles and traceable for at least 7 miles parallel to the coast, was auriferous and in many places contained rich placers.[45] Though the bonanza placers, especially those occurring in the several beach deposits, have been largely mined out, most of the auriferous gravel of lesser gold content is still undisturbed. This area of at least 28 square miles is the largest body of auriferous gravel known on the peninsula. This enormous bulk of gravel may not all be classed as gold placers, but drilling can determine what percentage of it contains workable placer ground. The use of heavier equipment and cold-water thawing, by lowering operating costs, will make available to profitable mining a greater percentage of the auriferous gravel than that previously estimated.

The reports of the Geological Survey show the very wide distribution of gold placers and the much wider distribution of auriferous gravel in Seward Peninsula. Nearly 20 years ago the facts then available about the occurrence of gold placers on Seward Peninsula were summarized, and the opinion was ventured that they contained gold to the value of $265,000,000 to $325,000,000.[46]

According to the original estimate, the creek placers carried about $50,000,000 worth of gold, and the coastal-plain and high bench placers, chiefly in the Nome district, were credited with placer reserves valued at about $215,000,000. Since this estimate was made about $50,000,000 in gold has been mined from Seward Peninsula placers. Crude as the original estimates of gold reserves were, the facts accumulated during the 20 years of mining do not lead to a modification of them. The mining of the coastal-plain placers has

[45] Moffit, F. H., Geology of the Nome and Grand Central quadrangles: U. S. Geol. Survey Bull. 533, pl. 3, 1913.

[46] Brooks, A. H., Outline of economic geology [Seward Peninsula]: U. S. Geol. Survey Bull. 328, pp. 111-138, 1908.

now been undertaken, but the mining on a large scale of high bench gravels has not yet begun.

The discovery of gold placers in the Buckland River basin was reported in 1922. This find was made by a native on what is called Koo-o-puk Creek, tributary to Buckland River, about 20 miles from tidewater and 25 to 35 miles east of Candle. In 1923 a number of miners reached the creek, and some gold was mined. This region has not been examined by the Geological Survey, and there is no information on the geology of the occurrence, but the discovery suggests an extension of the gold belt.

The metalliferous lodes of Seward Peninsula, including gold, silver, copper, antimony, lead, and tin, are not without promise,[47] but under present costs of operation and value of metals they are not likely to excite interest. Indeed, in 1923 there was no mining on the peninsula except that of placers and a small coal mine operated in the Fairhaven district. The discovery of large areas of bituminous coal on the Arctic coast (see p. 33) raises the question whether some of the mineral fuel brought to Nome (3,384 tons of coal in 1923) might best be supplied from this source. Some platinum was recovered from the gold placer mines of Dime Creek, in the Koyuk district.

The 16 dredges operated in Seward Peninsula in 1923 (see p. 27) were distributed by districts as follows: Nome, 6; Solomon, 3; Council, 3; Kougarok, 2; and Fairhaven, 1. One was also installed on Dime Creek and was operated for a short time before the end of the season. The value of gold recovery to the cubic yard varied with different dredges, from 13 to 90 cents; the average was 35 cents. The machines that were well equipped worked from 81 to 132 days. Some of the dredges were hampered by shortage of water due to the unusually dry season. This shortage also greatly curtailed all other forms of placer mining, as shown in the subjoined table. Had it not been for the increased gold output from the dredges, the production of 1923 would have been less than that of 1922.

Placer gold produced in Seward Peninsula in 1922 and 1923, by methods of mining

Method	Mines		Men		Value of gold		Gravel sluiced (cubic yards)		Value of gold recovered per cubic yard	
	1922	1923	1922	1923	1922	1923	1922	1923	1922	1923
Dredging	15	16	151	388	$609,859	$1,017,620	1,574,454	2,921,629	$0.39	$0.35
Hydraulic mining (includes all operations where any water is used to move gravel to sluice box)	24	16	192	144	426,671	179,207	468,147	148,740	.91	1.20
Open-cut mining (other than by hydraulicking and dredging)	59	24	136	47	117,736	21,883	39,972	11,148	3.00	1.96
Drifting	17	10	100	56	110,734	51,290	21,118	10,093	5.24	5.08
	115	66	579	635	1,265,000	1,270,000	2,103,691	3,091,610	------	------

[47] Cathcart, S. H., Metalliferous lodes in southern Seward Peninsula: U. S. Geol. Survey Bull. 722, pp. 163-261, 1922. Steidtmann, Edward, and Cathcart, S. H., Geology of the York tin deposits: U. S. Geol. Survey Bull. 733, 1922.

Placer gold produced in Seward Peninsula, 1922 and 1923, by districts

District	Value of gold		Summer				Winter			
			Mines		Miners		Mines		Miners	
	1922	1923	1922	1923	1922	1923	1922	1923	1922	1923
Nome	$485,000	$598,000	26	15	164	363	3	3	16	6
Solomon and Casadepaga	111,000	89,000	14	7	61	39				
Koyuk	109,000	59,000	11	9	78	41	4	2	25	20
Council	375,000	360,000	11	4	89	37	1		3	
Kougarok	32,000	50,000	11	9	35	40				
Fairhaven	150,000	107,000	26	9	93	69	3	1	7	3
Port Clarence	3,000	7,000	5	7	8	17				
	1,265,000	1,270,000	104	60	528	606	11	6	51	29

KOBUK REGION

Alluvial gold was reported in the Kobuk River basin as early as 1898, when the widespread Klondike excitement attracted gold seekers to many of the most remote parts of Alaska. Most of those going to the Kobuk left the following year, but a few remained and mined a little gold. The Shungnak district, in the Kobuk region, was the scene of the earliest mining, and by about 1907 more systematic development was begun, notably on Dahl Creek. The metallized areas near Shungnak, as determined by discoveries of gold, both in bedrock and in gravel, included an area about 10 miles square. Here the country rock comprises schist, slate, and limestone, with some igneous intrusives.[48] Some copper-bearing lodes have been found in this district, on which underground work has been done. From July to September Shungnak can be reached by river steamer from Kotzebue Sound, a distance of about 200 miles.

In 1910 gold placers were found on Squirrel River, which flows into the Kobuk about 60 miles from the sea. Kiana, at the mouth of Squirrel River, is the distributing point for the district and has a radio station. The geology of this district is similar to that of the Shungnak district, but no copper has been reported in it. In the Squirrel River district most of the placer mining has been done on Klery Creek, where gold has been found both in the creek and in the bench gravels. As shown by Smith's survey, the geology is much the same throughout the Noatak-Kobuk region, and there is no inherent reason why auriferous gravel should not occur at other localities than those described. Indeed, such deposits have been discovered and some placer gold has been mined on Agnes Creek, tributary to Ambler River in the Kobuk basin, and on Lucky Six and Midas creeks, in the upper Noatak basin. Some coal has been mined for local use on Kobuk River.

Mining in the Kobuk region was long limited to very small operations, consisting chiefly of open-cut work during the short summer

[48] Smith, P. S., The Noatak-Kobuk region: Geol. Survey Bull. 536, 1913.

season. A little deep placer mining has been undertaken in the region.

In 1922 and 1923 a hydraulic plant was installed on California Creek, in the Shungnak district. This installation, which was completed in 1923, includes a 2-mile ditch, 3,000 feet of pipe line, and a hydraulic elevator and is to be operated in 1924. This will be the first mining on a large scale in the entire region.

The statistics of gold production are very incomplete, but the figures given in the subjoined table are as accurate as may be had from the data in hand. The figures presented for the years since 1908 are based, so far as available, on the output of the individual mines, but as the returns are not complete, they have been supplemented by data obtained from various sources and are largely the estimates of local residents. Among those to whom special acknowledgment should be made are Mr. Lewis Lloyd, of Shungnak, who for 15 years has supplied the Geological Survey with valuable information about mining in the Kobuk region; and Messrs. M. F. Moran, Geo. L. Stanley, James C. Cross, and F. R. Ferguson, from whom important information has also been obtained.

Estimated value of placer gold produced in the Kobuk region, 1898–1923

Year	Mines	Men	Value of gold	Year	Mines	Men	Value of gold
1898–1902			$5,000	1914	7	15	33,000
1903			2,000	1915			20,000
1904			5,000	1916			20,000
1905			5,000	1917	17	25	25,000
1906			5,000	1918	19	49	15,000
1907			5,000	1919	16	40	25,000
1908			5,000	1920	12	19	8,000
1909			12,000	1921	13	25	7,000
1910			30,000	1922	9	19	8,000
1911	7	53	35,000	1923	8	13	8,000
1912	6	28	25,000				
1913	5	15	35,000				338,000

AN EARLY TERTIARY PLACER DEPOSIT IN THE YENTNA DISTRICT

By Stephen R. Capps

LOCATION AND GENERAL GEOLOGY

The Yentna gold-placer district lies at the western edge of the Susitna basin, on the southeastern flank of the Alaska Range, in south-central Alaska. It has been the scene of moderately active placer mining since the first discovery of gold there in 1905, and up to the end of 1923 it had produced about $1,500,000 in placer gold. Most of this gold has come from the basins of Cache and Peters creeks and their headward tributaries.

The general geology of the district in which the gold-placer deposits occur can be stated in fairly simple terms. This portion of the flank of the Alaska Range is composed mainly of a thick series of argillite, slate, and graywacke, of Mesozoic age, which have been highly deformed and considerably metamorphosed and are intruded, at a distance of 10 miles west of the placer mines, by large masses of granitic rocks. A few acidic dikes cut the slate and graywacke in the vicinity of the mines. The Mesozoic slate and graywacke are hard rocks and form high mountain ridges that border the basin of Cache Creek and upper Peters Creek both to the northwest and southeast. They show some mineralization, chiefly by disseminated cubes of pyrite. They contain abundant gash veins, stringers, and bunches of quartz, most of which is almost devoid of metallic minerals. A few quartz veins that carry gold in appreciable amounts have been found, and some fragments of vein quartz thickly studded with gold have been recovered from the sluice boxes by the miners. Many of the placer-gold nuggets contain some vein quartz, so there can be little doubt that the original source of the gold was in quartz veins carrying free gold.

Next younger than the Mesozoic slate-graywacke series is a series of gravel, sand, clay, and lignite beds that are correlated with the Kenai formation, of Eocene age. These partly indurated materials lie unconformably upon the Mesozoic slate and graywacke, are themselves considerably warped and deformed, are easily eroded, and so are now preserved only where their deformation has depressed them into synclinal basins in which erosion has been of only moderate severity.

The long time interval between the Eocene and the Pleistocene is not represented by recognized deposits in this district. This entire part of Alaska was heavily glaciated in Pleistocene time. Ice erosion greatly modified the preexisting topography, carved deep glacial troughs along the valleys of the main streams within the mountains, removed great quantities of the easily eroded Tertiary beds, and left a widespread mantle of glacial till and outwash gravel in the lowlands. In the Cache Creek and Peters Creek basin the ice erosion was severe, and large amounts of Eocene material were removed by glacial scour, but the position of the basin, bordered on the northwest and southeast by high mountain ridges and lying at right angles to the direction of the main ice movement in Kahiltna and Tokichitna valleys, gave it some degree of protection from glacial scour and prevented the complete removal of the relatively soft Eocene beds. The surface formation in much of the basin is now glacial till, which in places is known to be over 80 feet thick. This till is a characteristic deposit of unassorted stiff blue clay, studded with boulders and angular fragments of a wide variety of rocks.

Since the withdrawal of the glacial ice the streams have vigorously intrenched themselves into the basin filling of Eocene beds and the overlying glacial till and gravel, and they now occupy rather narrow, steep-walled cayons from 100 to 300 feet deep. The placer mining has been done mainly along the floors of these canyons. In general the bedrock beneath the stream gravel consists of the sand, gravel, clay, or coal beds of the Eocene series, but in places the streams have cut through to or into the harder Mesozoic slate and graywacke.

The location of the bedrock source of the placer gold has been open to question. No quartz veins capable of yielding the large amount of placer gold that the camp has produced and the additional large amount that still remains unmined have been found. The writer has expressed the belief[1] that the gold was originally derived from small, discontinuous quartz veins in the Mesozoic slate and graywacke, the veins being genetically related to the intrusion of these sediments by acidic igneous rocks, and this conclusion is confirmed by the present investigation.

PLACER DEPOSIT

In 1911 miners on Dollar Creek, a tributary of Cache Creek from the northwest, noticed while working upstream that the gold content of the stream gravel diminished rapidly above a certain point in the stream valley. In prospecting to discover the cause for this termination of the pay streak, a body of pebbles and subangular fragments of white quartz was found on the east wall of the valley, and this deposit was found to contain gold in minable amounts. At the time of the writer's first visit to the district, in 1912, only a small cut had

[1] Capps, S. R., The Yentna district, Alaska: U. S. Geol. Survey Bull. 534, p. 49, 1913.

been made at that place, and the conclusion,[2] based on the small exposures then accessible, was that the mining operations had uncovered a preglacial channel of Dollar Creek, buried beneath glacial till, and that the abundant quartz fragments and pebbles indicated the presence somewhere not far away of a considerable vein of gold-bearing quartz.

The Yentna district was visited by J. B. Mertie, jr., in 1917. By that time a large excavation has been made on the east bench of Dollar Creek, and a similar deposit had been opened and mined on Thunder Creek. Mertie[3] has described these deposits in some detail, and the following description has drawn freely on his observations, supplemented by those of the writer, who revisited the district in the summer of 1923. A third locality, in the upper valley of Willow Creek, in which ancient deposits of white quartz gravel,

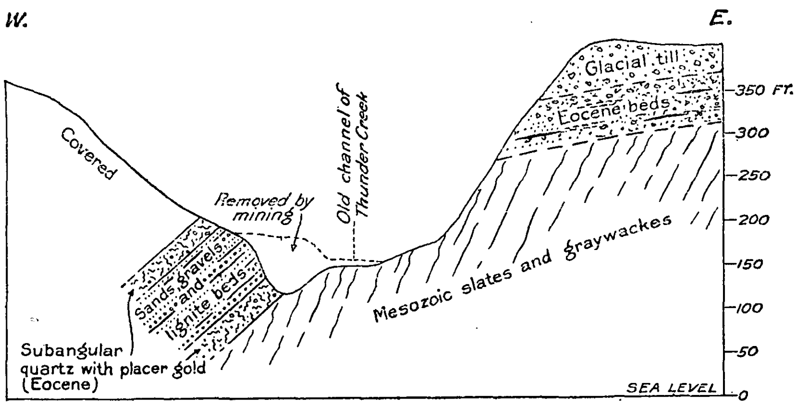

FIGURE 1.—Generalized cross section of Dollar Creek valley, showing geologic conditions at the placer mines.

unrelated to the present drainage lines, were proved to contain gold in paying quantities, extends the belt in which such deposits are known to a northeast-southwest length of 11 miles. The miners have been keenly alive to the commercial importance of these ancient gold-bearing gravels, and in the early months of 1923 they submitted a petition to the Geological Survey to send a geologist to the district, in order that he might study these deposits and advise them as to the source of the gold and the probable extent of the deposits. In response to this petition the writer spent a week in the district in August, 1923.

The largest exposure of the ancient gold placer is on Dollar Creek, about 4 miles above the mouth of that stream. There, on the east canyon wall, the placer-mining operations have opened a cut that

[2] Capps, S. R., op. cit., pp. 62–63.

[3] Mertie, J. B., jr., Platinum-bearing gold placers of the Kahiltna Valley: U. S. Geol. Survey Bull. 692, pp. 249–251, 252–254, 1919.

has a face over 1,500 feet long and averages over 100 feet high. The section exposed is shown in Figure 1. The sharply incised valley of Dollar Creek was cut through the surface layer of glacial till, through the Eocene deposits of poorly rounded quartz, assorted gravel, sand and clay lenses, and thin lignite beds, and into the underlying Mesozoic slate and graywacke. The Mesozoic beds, striking about N. 25° E. and dipping from 60° E. to 90°, are seen to contain abundant bunches and gash veins of quartz, most of which seems to be devoid of mineralization. In the valley of Dollar Creek the slate and graywacke are hard, fresh, and unweathered, but on the old surface from which the overlying Tertiary beds have been removed by mining there is evidence of long-continued weathering and decay, the graywacke having broken down into incoherent sand and the argillite and slate into clay. There can be no doubt that before the beginning of Tertiary deposition here the older Mesozoic rocks had been subjected during a long period to surface weathering and erosion, in which the surface was reduced and the exposed rocks were deeply weathered and decomposed.

The Tertiary deposits, of Kenai (Eocene) age, lie unconformably upon the weathered and decomposed surface of the Mesozoic slate and graywacke. The lower portion of the Eocene beds, in places having a thickness of 60 feet, consists primarily of subangular or partly rounded fragments of quartz, with some imperfectly rounded graywacke fragments, and a smaller number of well-rounded pebbles of quartz and graywacke, the pebbles and fragments all embedded in a bluish-white clayey matrix that is itself composed largely of broken vein quartz and siliceous clay. This quartzose stratum is gold bearing throughout, though there is a main concentration of gold on or near the slate-graywacke bedrock, and other minor concentrations occur on the upper surfaces of clayey bands and lignite beds. Conformably above the quartzose stratum there is a varying thickness of well-rounded gravel, and this is succeeded above by a 50 to 80 foot layer of blue glacial till which itself carries some gold.

In mining these claims the entire body of Eocene materials and the overlying glacial till are washed down with hydraulic giants, operating under a head of about 200 feet, and put through the sluice boxes. Both Eocene materials and glacial till are closely compacted and tenacious and yield to the hydraulic stream with difficulty. Under the influence of the weather, however, the material slowly disintegrates and may then be sluiced readily. The gold recovered is conspicuously rough and angular and in general shows the crystalline outlines of the vein quartz crystals in which it was embedded. Very little of it shows much evidence of stream wear and smoothing, and it has certainly been transported only a very short distance from its bedrock source. It ranges in coarseness from tiny colors to nuggets having a value of as much as $90. The gold assays about $17.60 an ounce. The sluice-box concentrates contain large amounts of pyrite carrying much gold, as well as magnetite, ilmenite, zircon, garnet, and cassiterite. As the materials sluiced include a large quantity of glacial till that contains material of widely diversified origin, it is impossible to be certain of the bedrock origin of many of these sluice-box concentrates.

Another locality at which the basal Tertiary materials have been mined for their placer gold is on Thunder Creek, about a mile above the mouth of that stream. Figure 2, a section of the stream valley at that place, shows a close similarity to the conditions on Dollar Creek illustrated in Figure 1. At the workings of 1923 the underlying slate-graywacke bedrock is overlain unconformably by 60 feet or more of Tertiary sediments that include at their base a deposit of

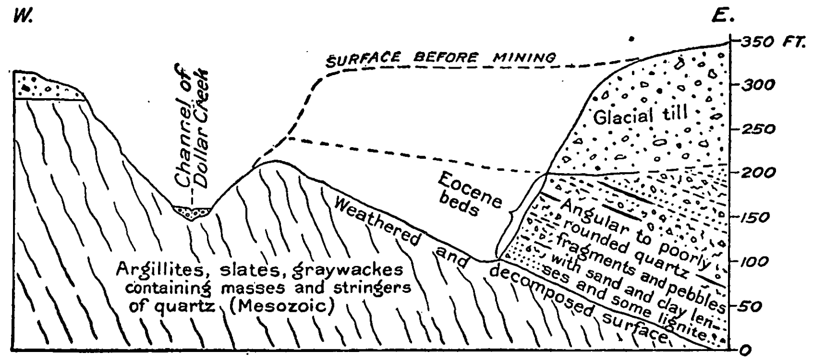

FIGURE 2.—Generalized cross section of the valley of Thunder Creek, showing stratigraphic relations of Mesozoic beds, Eocene deposits, and glacial till.

subangular quartz fragments with a few rounded quartz pebbles, embedded in a matrix of white clayey fragmental quartz and siliceous clay. This deposit is succeeded above by sand, clay, gravel containing lignite seams and fragments, and at about 50 feet above the base of the Tertiary by another quartzose bed, the materials of which are more perfectly rounded than those of the lower quartzose layer. The surface portion of the underlying slate and graywacke is deeply weathered and decomposed, contains numerous quartz bunches and gash veins, and shows evidence of having been long subjected to atmospheric disintegration before it was covered by the Tertiary sediments. The placer gold recovered is sharp and rough and shows almost no indication of having been transported far by streams. The principal gold concentration occurs in the basal portion of the lower quartzose stratum, or in the surface of the underlying decomposed slate and graywacke. A little gold is found in the Tertiary beds higher in the section, and a notable concentration in the upper quartzose bed. The gold is coarse, nuggets worth as much as $96 having been recovered. The gold assays $18.10 an ounce. The Tertiary beds on this creek have been mined for their gold content for several years by hydraulic methods, but the tenacious character of the beds makes them difficult to break down and limits the quantity that can be disintegrated and sluiced. Both the Mesozoic slate and graywacke and the Eocene beds are cut by faults, most of which are of small displacement. The character of the quartz fragments in the bedded Eocene deposits is strikingly like that of the gash veins and bunches in the underlying Mesozoic slate and graywacke. Most of the quartz is almost entirely lacking in visible mineralization, although on this creek a number of pieces of quartz thickly studded with gold have been found in the sluice boxes.

A third locality at which the quartzose beds at the base of the Tertiary sediments have been mined for their gold content is on the head of Willow Creek, a tributary of Cottonwood Creek, which joins Peters Creek just above the canyon through which that stream crosses the Peters Hills. At the extreme head of the Willow Creek basin, where numerous small streams drain the steep eastward slope of the Dutch Hills, there is a deposit of white, well-rounded gravel in a white siliceous clay matrix that contains sufficient placer gold to justify mining. The stratigraphic relations at this place are much less plain than on Thunder and Dollar creeks, for the deposit has been greatly confused and disturbed, probably by landslides. Nevertheless, from the prevailing association of the quartz-gravel deposit with a decomposed phase of the Mesozoic slate and graywacke, it is evident that here also the quartz gravel represents the oldest Tertiary beds at this place, though here both the quartz fragments and the associated placer gold are more rounded and worn and show evidence of having been transported farther from their source than in the Tertiary quartzose deposits on Thunder and Dollar creeks.

SUMMARY OF PERTINENT FACTS OF OBSERVATION

As a result of a study of the three localities at which the ancient quartzose deposits have been mined for their placer gold, a few general statements may be made as to the character and stratigraphic relations of these deposits. The quartzose deposit lies at the base of the Eocene formation, at its unconformable contact with the eroded and deeply weathered Mesozoic slate and graywacke. This series of Mesozoic rocks is highly folded and deformed, the beds generally dipping at high angles, and carries abundant gash veins and bunches of quartz that is similar in appearance to the great volume of quartz present in the Eocene beds. These quartz lenses and bunches are for the most part nearly devoid of mineralization, but it is likely that there are present other small veins, possibly of different age, that carry abundant free gold. Fragments of such veins have been found in the sluice boxes.

The lowest portion of the Eocene formation is composed mainly of quartz fragments that, on Thunder and Dollar creeks, are for the most part subangular or only partly rounded. This quartz is partly disintegrated and breaks up easily into fine angular fragments. A few well-rounded pebbles were seen at these places, and on Willow Creek the material is noticeably more worn. The pebbles and subangular fragments lie in a tenacious white siliceous clay, full of fine fragments of quartz. From the base of the Eocene series upward the proportion of quartz in the deposit decreases, and sand, clay, and lignite beds occur. Locally quartzose beds recur at intervals in the lower portion of the Eocene series. Some small faults, of a few feet displacement, cut both the Mesozoic and the Tertiary beds.

Placer gold occurs in small amounts through the basal portion of the Eocene series on Dollar, Thunder, and Willow creeks, but the principal concentration is found within the lower 2 feet of the basal quartzose bed, or on the surface of the underlying decomposed slate and graywacke. There is some concentration also upon the upper surface of clay and lignite beds and in the layers of fragmental quartz that occur higher in the section. The gold itself is coarse and remarkably rough and angular, showing the imprint of the vein-quartz crystals in which it was originally embedded. Since it was released from the parent quartz veins it obviously has not been transported far by streams to the quartzose beds in which it is now found. The angular to subangular character of the quartz fragments in the quartzose beds also indicates that this material has undergone only a small amount of stream handling and transportation.

Since their deposition the Eocene beds have been warped into irregular basins, so that dips in all directions may be found. The whole district was overridden, during Pleistocene time, by a thick body of glacial ice that eroded away large quantities of rock. In places where the Eocene beds had been warped and folded the domes and anticlines have been planed off by the glaciers, and the Eocene beds and also some of the underlying Mesozoic materials have been removed. The whole surface was covered by a sheet of glacial till that in places reaches a thickness of 80 feet. This till carries some gold, though generally in too small quantities to justify mining unless the material overlies richer deposits that are to be mined anyway.

From the facts just cited it is possible to reconstruct the series of events that took place in this district and gave rise to these interesting placer deposits. The major events in the series are believed to be as follows:

1. In the time preceding the deposition of the earliest Tertiary beds of the Cache Creek district the land-surface was composed

of Mesozoic slate and graywacke that contained abundant quartz veins and bunches, most of which carried little gold, but some of which presumably carried free gold in considerable amounts. The surface of this group of quartz-bearing sediments was exposed to atmospheric weathering and erosion for a long time, was reduced to mild relief, and was covered by an accumulation of residual quartz that had weathered out from the slate and graywacke. Along with the quartz was a residual concentration of gold, freed from the rocks and the gold-bearing quartz veins by their disintegration.

2. In early Tertiary time certain deformations of the land surface took place that rejuvenated the drainage, and the residual surface accumulations of quartz and gold were carried from the elevated areas to near-by lowlands and there deposited.

3. Later in Tertiary time, the supply of residual quartz in the highlands having been largely exhausted, the streams attacked the underlying slate and graywacke. More slate and graywacke pebbles appeared in the gravel, and gravel deposits alternated with sand, clay, and lignite beds. All the clastic materials contained a little gold, but notable concentrations were formed only in the basal quartzose layer, on the top of clayey beds, or in later beds of fragmental and partly rounded quartz.

4. After the deposition of the Eocene beds was completed they were warped into irregular basins.

5. In Pleistocene time a great glacier advanced through this district, deeply eroded all the surface formations, and removed great quantities of Eocene and older materials, in places planing the Eocene beds entirely away and cutting into the underlying slate and graywacke. Later the glacier deposited a thick layer of glacial till over the surface of the lowland. This till contained the gold of those parts of the basal Eocene that the glacier had eroded and also the gold of any stream placers that had been eroded by the ice and incorporated in the till.

6. After the retreat of the ice the present streams began to intrench themselves into the glacial deposits, and they have now succeeded in many places in cutting through the till and the underlying Eocene beds and locally into the Mesozoic slate and graywacke. In so doing they have concentrated in their beds the gold that was distributed through the glacial till and the Eocene deposits and that which occurred in the quartz veins in the Mesozoic slate and graywacke.

CONCLUSIONS

It has been generally believed by the miners that the Eocene quartzose beds are old stream-channel deposits and that the angular character of the quartz and the gold indicate the presence somewhere in the vicinity of large auriferous quartz veins. Such an origin also implies that the quartzose deposits have long, narrow outlines and are of sharply limited area. The writer's concept—that the quartzose deposits are bedded deposits, coextensive with the base of the Eocene formation, and that the quartz is derived by weathering from the Mesozoic slate and graywacke, which contain a multitude of small bunches and veinlets—does not support the expectation that large gold quartz veins will be found. It does imply, however, that the quartzose beds have a much wider distribution than they would have if they were proved to be stream-channel deposits. It is not to be expected that the basal Eocene quartzose beds will everywhere contain placer gold in minable amounts, for their gold content at any particular place has been determined by the gold tenor of the quartz veins in the small area that supplied the materials of the deposit. Nevertheless, the knowledge that the basal Eocene quartzose beds contain placer gold in paying quantities over a rather wide area greatly increases the area favorable for prospecting, and those localities where the Eocene sediments are in contact with the Mesozoic slate and graywacke deserve prospecting with care.

15288°—25†——5

ADMINISTRATIVE REPORT

By Alfred H. Brooks

The systematic investigations and surveys of Alaska mineral resources began in 1898 and therefore in 1923 had been carried on for a quarter of a century. The great task before the Geological Survey was to determine the distribution and forms of occurrence of the valuable minerals of a region including 586,400 square miles, which was difficult of access and about which very little was then known. Most of the coast line had been fairly well charted by the Coast and Geodetic Survey, but inland Alaska was but imperfectly known by the explorations of a few pioneers. The Geological Survey had in 1895 and 1896 made a hasty exploration of the mineral resources of the Pacific seaboard and of the Yukon placer districts. Only the courses of the larger rivers were known, and no instrumental surveys had been made of inland Alaska. No understanding of the mineral deposits could be had except by the preparation of a geologic map, and the making of such a map required first the making of topographic surveys.

The basal plan of the first few years of work was to extend a network of exploratory surveys over the Territory, which would block out its larger physical features. This type of work was followed by areal surveys on a scale of 4 miles to the inch, which was adopted as the standard of the geologic and topographic maps of Alaska. Areas of special economic importance were to be mapped on a scale of 1 mile to the inch as fast as the appropriations permitted. On the average, it now costs about $10 a square mile to survey the topography and geology of Alaska; the detailed surveys will cost $30 to $50 a square mile.

Standard geologic and topographic maps have now been completed of about 200,000 square miles. At least half of the unsurveyed area is so inaccessible that its mapping may be deferred, but there are areas covering about 200,000 square miles of which geologic and topographic maps are needed to determine mineral resources that may possibly be of great importance. At the rate of progress in the past, it will require 50 years to complete this preliminary work. This estimate takes account of the fact that there are many districts which should be surveyed in the same detail as that used for the standard maps made in the States, as well as subjected to special geologic study in addition to the geologic mapping.

The need of geologic surveying as a basis for industrial development is so generally recognized that it requires no argument. It is especially important in new lands, however, to furnish the scientific facts on which to assure an orderly industrial development and to avoid the hit or miss policy which has been so often disastrously employed. In Alaska, too, there is the special Federal interest in the task because of the large expenditures on the Government railroad, which must find its main support from the production of mines. This interest calls for an early survey of the region tributary to the Alaska Railroad. It is evident then, that the parts of Alaska that should first be surveyed are the accessible parts, which will include the Pacific slope as well as the regions opened up by the railroad. Among these are the Alaska Peninsula and a belt to the north, which includes possible petroleum and coal resources, also a large unmapped area stretching westward from the head of Cook Inlet to Kuskokwim River and a tract lying south of Tanana River, between Delta River and Mentasta Pass, which is known to include some metal deposits. In northern Alaska a survey of the unmapped Buckland and Selawik basins is also believed to be important. The completion of the geologic mapping of southeastern Alaska is urgently needed.

Alaska's potential water power is estimated to aggregate about 2,500,000 horsepower, of which some of that on the Pacific slope is of immediate economic importance. The facts needed for utilization of water power in addition to topographic surveys are stream-gaging observations extending through a long period of years. The Geological Survey began this work in 1906 by measurements of stream volume in Seward Peninsula and later extended these measurements to other inland placer districts as well as to water powers of the Pacific seaboard. The most important of these were records for five years in southeastern Alaska, obtained before 1920, when the work was stopped on account of lack of funds. It is needless to say that if the potential water powers of Alaska are to be utilized, further expansion of such surveys is essential.

A retrospect of the accomplishments during 25 years of investigations in Alaska will show that these reflect great credit on the many who have taken part in the task. Alaska's geography, geology, and resources—thanks to the work of the geologist and the engineer—have become well known, and many of the details are recorded in maps and publications.[1] It is, however, evident that if this vast land and its resources are to be fully utilized by the large population it can support, the task of its survey and investigation is but fairly well begun.

In 1923 ten parties were engaged in surveys and investigations in Alaska. Of these, seven operated under the appropriation of $75,000

[1] The Geological Survey has published over 420 maps and 383 reports treating of Alaska.

for investigating the mineral resources of Alaska and included in their personnel 7 geologists, 2 topographers, and 11 recorders, rodmen, packets, cooks, and other helpers. Five of these parties were engaged in geologic work, and two were combined geologic and topographic parties. Three combined geologic and topographic parties were engaged in surveying Petroleum Reserve No. 4, on the northern coast of Alaska. This work was done under a grant of $75,000 to the Department of the Interior from the Department of the Navy. These three parties included 3 geologists, 2 topographers, 1 topographic assistant, and 17 rodmen, boatmen, packers, cooks, and other helpers.

Allotments for salaries and field and office expenses, field season of 1923

	1922-23	1923-24
Professional salaries		$28, 887
Field expenses	$14, 100	14, 000
Clerical salaries and other office expenses		6, 870
Office of Director		10, 992
To be allotted to field work, 1924		14, 251
	14, 100	75, 000

This statement includes only the appropriation made for the investigation of Alaska mineral resources; the other grants from naval appropriations and from funds for public-land classification are referred to below.

Allotments of naval fund, field season of 1923

Professional salaries	$12, 411
Field expenses	39, 877
Miscellaneous expenses, including clerical salaries	1, 900
Office of Director	1, 512
Allotted to field work, 1924	19, 300
	75, 000

The following grants have been made for the classification of the Alaska public lands and have been entirely devoted to the surveys of petroleum lands: 1921, $12,000; 1922, $2,000; 1923, $6,000.

The allotments shown in the subjoined tables as made to different kinds of work and to different regions are only approximations. To determine the precise 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 table shows, in a general way, however, on what project the funds have been spent. The geologic surveys include work that is used in the classification of public lands, which, as already shown, has in part been paid for from another appropriation for that purpose. These additional grants are not included in these totals and have all been spent on petroleum lands. They increase the allotment shown in these tables for geologic work in the first and for similar work on the Alaska Peninsula in the second.

Approximate allotments to different kinds of surveys and investigations, field season of 1923

	1922-23	1923-24
Special investigation of geology and mineral resources	----------	$10,990
Geologic reconnaissance surveys	$10,000	15,130
Topographic reconnaissance surveys	4,100	7,500
Map compilation	----------	2,200
Collecting mineral statistics	----------	1,560
Administration of Alaska branch, including clerical salaries and miscellaneous expenses	----------	12,377
Office of Director	----------	10,992
To be allotted to field work, 1924	----------	14,251
	14,100	75,000

Approximate geographic distribution of allotments for investigations in Alaska, field season of 1923

	1922-23	1923-24
Special investigation of geology and mineral resources	$2,935	$4,150
Southeastern Alaska	1,600	3,870
Prince William Sound	860	5,000
Alaska Railroad region	----------	2,600
Alaska Peninsula	4,780	14,500
Yukon basin	3,925	3,500
Map compilation	----------	2,200
Mineral statistics	----------	1,560
Administration of Alaska branch, including clerical salaries and miscellaneous office expenses	----------	12,377
Office of Director	----------	10,992
To be allotted to field work, 1924	----------	14,251
	14,100	75,000

The following table shows the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898.[2] A varying amount is spent each year on investigations of geology and mineral resources the results of which can not be expressed in terms of area.

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

Progress of surveys in Alaska, 1898–1923

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)	Lines of levels	Bench marks set	Gaging stations maintained part of year	Measurements of stream volume
		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	75,000	----	3,500	----	----	1,200	----	----	----	----	----
1919	75,000	----	2,700	----	----	2,300	----	----	----	19	----
1920	75,000	----	1,480	----	----	770	----	----	----	19	----
1921	[b] 75,000	----	2,130	150	----	300	205	----	----	----	----
1922	[b] 75,000	----	4,000	----	----	4,300	----	----	----	----	----
1923	[b] 75,000	----	8,570	----	----	6,530	----	----	----	----	----
	2,011,189	73,200	123,665	5,657	51,680	163,430	3,936	462	74	----	----
Percentage of total area of Alaska	----	12.48	21.09	0.96	8.81	27.87	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] In 1921–1923 additional funds were available; see p. 65.

The chief Alaskan geologist was engaged in Alaska work until June 21, 1923, when he left for Seattle, Wash., on administrative duty. From July 1 to October 10 he was absent as an official delegate to the Pan-Pacific Science Congress in Australia. His time in the Washington office was divided as follows: Geology and geography of Alaska, 61 days; progress report, 19 days; press bulletin, 8 days; mineral statistics, 24 days; reading and revising reports of others, 25 days; field plans and orders, 30 days. The balance of office time was devoted to miscellaneous administrative duties.

On June 21, 1923, S. R. Capps took over the administrative duties of the branch, previously performed by G. C. Martin, Mr. Capps then becoming acting chief Alaskan geologist in the absence of the chief. In addition to doing his own geologic work, he devoted 125 days in the office to administrative work. Miss Lucy M. Graves, chief clerk, acted as chief of the branch during part of the field season. Miss Erma C. Nichols devoted about two-thirds of her time to collection and coordination of mineral statistics.

R. H. Sargent continued to supervise topographic surveys and map compilation. He devoted 112 days of office time to administrative work.

A. F. Buddington spent from May 22 to September 14 in the continuation of his investigation of geology and mineral resources of southeastern Alaska. Special attention was given to the Hyder district and to the nickel deposits of the Sitka district.

F. H. Moffit was engaged from June 1 to September 15 in a continuation of the study of the copper deposits of Prince William Sound and incidentally thereto mapped the geology of about 400 square miles on a scale of 4 miles to the inch.

S. R. Capps was engaged during the month of July in continuing his study of the metal deposits of the region tributary to the Alaska Railroad.

R. H. Sargent, with Kirtley F. Mather, geologist, carried a reconnaissance survey from Kamishak Bay to Katmai during the period included between June 21 and August 28. This party mapped an area of 3,150 square miles topographically and 2,200 square miles geologically, both on a publication scale of 4 miles to the inch.

R. K. Lynt, with Walter R. Smith, geologic aid, mapped an area of 1,300 square miles topographically and 1,000 square miles geologically, lying between Katmai on the north and Cold Bay on the south. This work was done for publication on a scale of 4 miles to the inch.

George C. Martin devoted the time from July 18 to August 28 to a continuation of the study of the stratigraphy of Alaska Peninsula. He gave special attention to the Cold Bay petroleum field and to the Chignik district.

J. B. Mertie, jr., carried a geologic reconnaissance survey from Beaver, on the Yukon, to the Chandalar district. Later he studied the geology along the Yukon between Beaver and the Tanana. The total area investigated by him included about 4,000 square miles, of which about half was new mapping.

Sidney Paige led an expedition to investigate the oil resources of Naval Petroleum Reserve No. 4. The field work began about July 15 and ended about September 9. The northern party, including Sidney Paige, geologist, and E. C. Guerin, cadastral engineer, worked from Wainwright around Point Barrow to Dease Inlet and thence up Meade River about 150 miles. The northeastern party, including James Gilluly, geologist, and J. E. Whitaker, topographic assistant, went overland from Peard Bay down to Inaru River and explored Topagarok River for 40 miles. The southern party, including

William T. Foran, geologist, and Gerald FitzGerald, junior topographer, landed near Cape Beaufort and surveyed the shore line north to Icy Cape. It mapped Kukpowruk River inland for 35 miles, Kokolik River for 25 miles, and Utukok River for 40 miles and explored the lower part of Wainwright Inlet.

The Paige expedition in all mapped 2,150 square miles, but the exploration has thrown much light on 10,000 square miles in northern Alaska. The surveying was done chiefly on a scale of 1:96,000, but as the maps will be published on a scale of 4 miles to the inch, it is here classed as reconnaissance work.

C. Arthur Hollick completed his studies of the Alaska Tertiary flora, and the resulting manuscript will soon be submitted.

James McCormick was employed in the Alaska branch for a part of the year in preparing a revision of the geographic dictionary of Alaska.

During 1923 the Survey issued two complete bulletins relating to Alaska—Bulletin 739, "Mineral resources of Alaska, 1921," by Alfred H. Brooks and others, and Bulletin 745, "The Kotsina-Kuskulana district, Alaska," including topographic maps, by F. H. Moffit and J. B. Mertie, jr.; also two separate chapters from Bulletin 755, "Mineral resources of Alaska, 1922," by Alfred H. Brooks and others. Bulletin 754, "The Ruby-Kuskokwim region, Alaska," by J. B. Mertie, jr., and G. L. Harrington, was issued in March, 1924. The manuscripts of four reports—on the Mesozoic stratigraphy of Alaska, by G. C. Martin; the Upper Cretaceous flora of Alaska, by Arthur Hollick, with a description of the Upper Cretaceous plant-bearing beds, by Geo. C. Martin; the Point Barrow region, Alaska, by Sidney Paige, William T. Foran, and James Gilluly; and Aniakchak Crater, Alaska Peninsula, by W. R. Smith, are nearly ready for the printer. The usual annual review of the mining industry of Alaska was issued on December 31, 1923.

The following Alaska maps were published in 1923: A new map of Alaska on a scale of 1 to 2,500,000, a relief map of Alaska on a scale of 1 to 2,500,000, and a new edition of the index map of Alaska on a scale of 1 to 5,000,000. The following maps have been issued in 1924: "Northwestern part of Naval Petroleum Reserve No. 4, Alaska," surveyed for the Department of the Navy by the Department of the Interior, on a scale 1 to 500,000, issued in April; "Cold Bay-Chignik, Alaska Peninsula," on a scale of 1 to 250,000, in April; "Iniskin Bay-Snug Harbor district, Cook Inlet region, Alaska," on a scale of 1 to 250,000, in May; and the topographic map of the region tributary to the Alaska Railroad, on a scale of 1 to 250,000, in three sheets (Seward to Matanuska coal field, Matanuska coal field to Yanert Fork, and Yanert Fork to Fairbanks) in June and December.