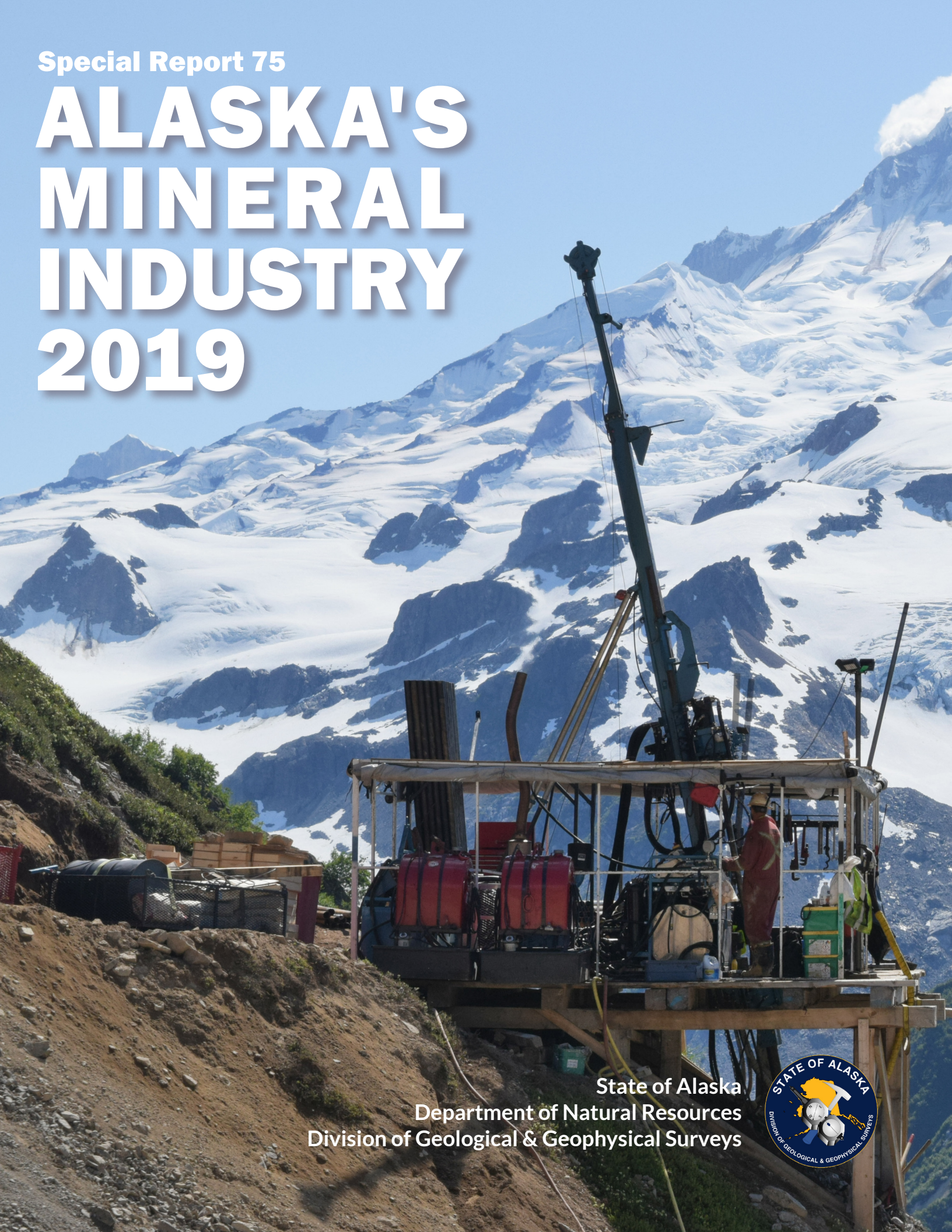
Special Report 75

ALASKA'S MINERAL INDUSTRY 2019



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Alaska's Mineral Industry 2019

Jennifer E. Athey[1], Melanie B. Werdon[1], and Evan Twelker[1]

Cover. Hy-Tech Drilling USA Inc. drill rig on the Johnson Tract gold and base-metal property in south-central Alaska being explored by HighGold Mining Inc. Mount Iliamna (volcano) is in the background. Photo courtesy of Ian Cunningham-Dunlop, HighGold Mining Inc.

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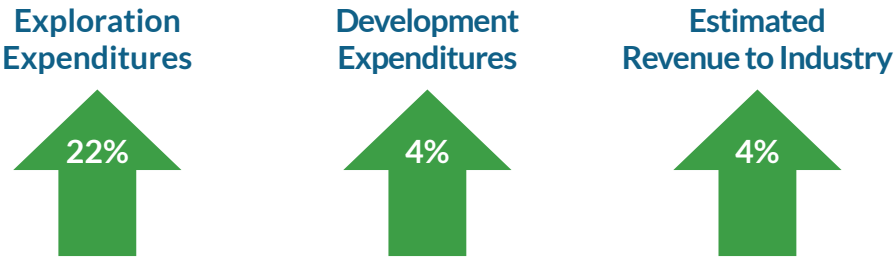
EXECUTIVE SUMMARY

This summary of the status of Alaska's mineral industry for 2019 is the 39th such annual report produced by the Department of Natural Resources, Division of Geological & Geophysical Surveys and partner agencies. Published for more than one-third of a century, the annual report endeavors to provide a consistent and factual snapshot of mineral industry activity in Alaska. It also serves as the authoritative historical record of mining in the State.



The reported value of Alaska's mineral industry in 2019 totaled $3.0 billion, an increase of 5 percent from 2018. The total value for 2019 is a composite of the year's expenditures on exploration and development, plus the revenue to the operators from the commodities produced.

Nearly all measures point towards a healthy Alaska mining industry in 2019, with plenty of space available for future growth. Companies spent more on exploration and development in 2019. Revenue to industry increased more than four percent despite drops in zinc and gold production and lower base-metal prices. Increased silver production and higher gold and silver prices drove industry revenue into positive territory.

Zinc continued to be the top metal produced in 2019—accounting for nearly 54 percent of Alaska's total metal production by value. Gold followed at almost 29 percent. Silver outpaced lead in 2019; silver's production volume increased almost 17 percent, and its value rose more than 22 percent.

Development expenditures in Alaska rose more than four percent in 2019—to $347.8 million. Nearly all development spending was attributable to the operating mines, including Alaska's new Dawson mine that produced its first gold in 2019.

Mineral exploration expenditures grew 22 percent from 2018, rising to $171.0 million. Alaska exploration was a bright spot globally, as the worldwide exploration budget decreased three percent in 2019.

Mining claims and prospecting sites covered more than 3.5 million acres of Alaska in 2019, a drop of more than seven percent from 2018. The total number of new 160-acre claims and prospecting sites staked increased by 51 percent and 291 percent, respectively, covering almost 620,000 new acres in 2019.

Overall mineral industry employment remained relatively flat in 2019 at 3,486 full-time-equivalent jobs, with a modest increase of about 17 jobs (0.5 percent) from 2018. The production sector gained 87 jobs, while the exploration and development sectors declined.

Estimated revenues to the State of Alaska and municipalities from mineral-industry-specific fees, rents, sales, royalties, and taxes amounted to more than $126.1 million in 2019, a decrease of almost 13 percent from 2018.

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Tracking Alaska's mineral industry:

Estimated revenue to industry versus theoretical first market value

This report began a new method of tracking the value of Alaska's mineral production starting with the 2016 mining year.

'Estimated revenue to industry', as reported voluntarily by mining companies, is now the primary method for tabulating annual mine revenue from production in Alaska; 'estimated first market value' figures tabulated prior to 2016 have now been more accurately retitled 'theoretical first market value' (table 1).

The new 'estimated revenue to industry' figure accounts for actual sales revenue, including the effects of stockpiling, price hedging, the price at the time of sale, smelting and refining charges, and transportation of the final product.

The 'theoretical first market value' figure simply reflects the total amount of each commodity produced multiplied by the average price for that year; the simplicity of this approach means that the theoretical first market value figure can significantly overstate the revenue realized by the operator. For example, there is a more than $400 million difference between estimated revenue received by operators in 2019 and the theoretical first market value for 2019. When actual revenue values are either not voluntarily reported or must be withheld for reasons of confidentially, theoretical first market values will be used instead.

In the "Government Revenues from Alaska's Mineral Industry" section, total gross income from mining operations and royalty as reported on Alaska Mining License Tax returns and explanatory text are also available for comparison with the estimated revenue to industry values from 2016–2018.

INTRODUCTION

Alaska's mineral potential is evident from its historically significant production: placer gold from the Fairbanks and Nome mining districts, copper from the Kennecott area, lode gold from the Alaska–Juneau (A–J) and Treadwell mines near Juneau, and placer platinum from the Goodnews Bay Mining District. Alaska's major deposits currently in production include Red Dog, Greens Creek, Pogo, Fort Knox, Kensington (photo 1), and Usibelli Coal mines. Alaska added an additional operating gold mine in 2019, the Dawson mine in southeastern Alaska. Promising advanced-exploration and permitting-phase projects include Donlin Gold, Pebble, Livengood, Niblack, Palmer, Arctic, Bornite, and Lik deposits. These deposits and others, found throughout Alaska's seven geographic regions defined for this report (fig. 1), collectively represent a significant proportion of United States domestic gold, silver, copper, and base-metal resources; their presence demonstrates Alaska's geologic favorability for generating additional very large mineral deposits. Significant resources of other commodities include the advanced-exploration projects Graphite Creek (graphite deposit) and Bokan Mountain (rare-earth-element deposit), promising future domestic sources of critical raw materials needed for twenty-first-century technologies. Without a doubt, Alaska holds other world-class mineral deposits yet to be discovered. In 2019 Alaska was ranked 4th out of 76 worldwide jurisdictions for overall investment attractiveness by mining and exploration companies, which takes into account geologic potential as well as government policy factors that affect exploration investment.[2]

Photo 1. Kensington mine in southeastern Alaska poured its millionth gold ounce in 2019. Photo courtesy of Jan Trigg, Coeur Alaska, Inc.

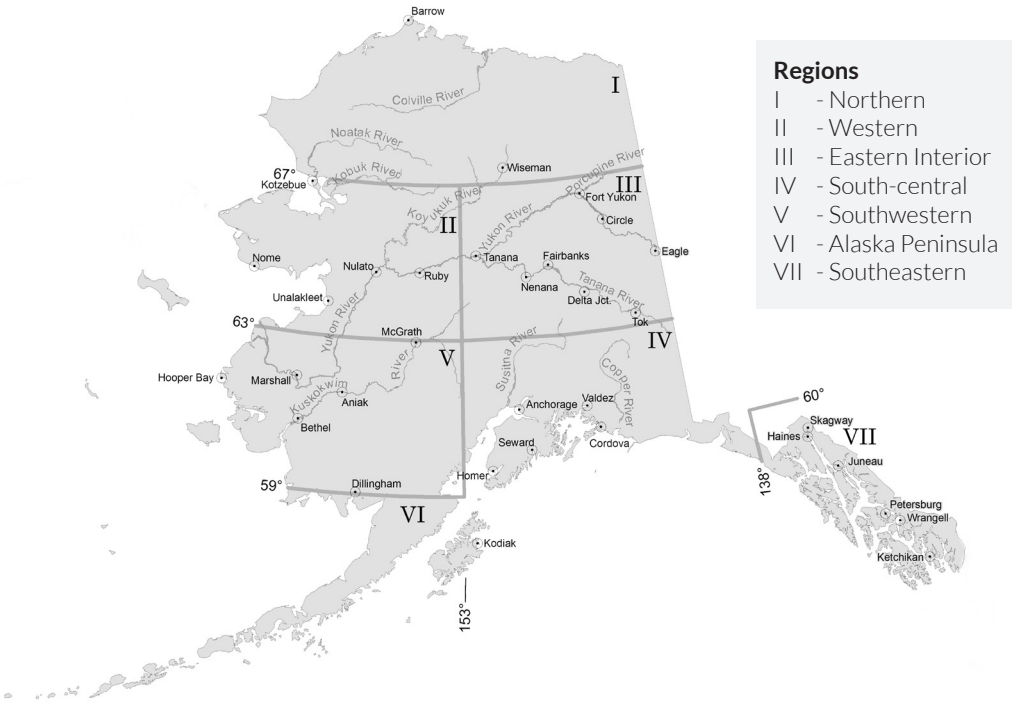


Figure 1. Regions of mineral activity as described in this report.

[2]Stedman, Ashley, Yunis, Jairo, and Aliakbari, Elmira, 2019, Fraser Institute Annual Survey of Mining Companies, 2019: Fraser Institute, 76 p. www.fraserinstitute.org

It is the policy of the State of Alaska to encourage the settlement of its land and the development of its resources by making them available for maximum use consistent with the public interest (appendix A). Alaska, in its strategic Pacific Rim location, offers prospective land, sanctity of title, State-sponsored geological and geophysical mapping, a reasonable permitting process coordinated among agencies, a capable workforce, exploration incentives, and innovative infrastructure equity-sharing programs. More than 190 million acres of Federal, State, and Native-owned lands are open for mineral-related activities and mining. This allows the minerals industry to be a driving force in the State's economy through significant local employment, infrastructure, and government revenue.

Alaska's mineral industry displayed mostly positive trends in 2019. Unlike the depressed 2019 global exploration budget, exploration activity in Alaska jumped 22 percent to $171.0 million: just shy of the average amount of annual exploration spending over the last decade ($178.5; table 1). Development expenditures in Alaska, an indicator of future production, totaled $347.8 million in 2019: up four percent from $334.1 million in 2018. The amount of most commodities produced, except notably for silver (and lead), decreased in 2019. Despite the drop, revenue to industry increased by more than four percent due to higher precious-metal prices and internal company strategies.

The exploration, development, and production values used in this report are compiled from past-year statements issued by companies, including press releases and corporate annual and financial reports, as well as phone interviews, replies to questionnaires, and news media articles. Average metal prices used in the first-market-value calculations that are incorporated into estimated mining revenues and commodity values are based on average daily prices on the London Metal Exchange. Coal prices are estimated from average coal prices for similar-grade material around the Pacific Rim. Industrial materials prices are based on regional rates reported by operators. Many of the numbers contained in this report are estimates: commodity values and company revenue estimated from theoretical first market values are likely to be overstated, while numbers based on voluntary reporting are likely to be minimum estimates of the value of the mining industry to Alaska's economy.

This report is a cooperative project led by the Alaska Division of Geological & Geophysical Surveys (DGGS) in the Department of Natural Resources (DNR), with support from the DNR Division of Mining, Land & Water (DMLW), the Department of Labor and Workforce Development (DLWD), and the Department of Revenue (DOR). The agencies involved in producing this report are committed to producing a reliable annual commentary on mineral industry activity in Alaska, which is vital for informed decision-making by State and local governments, the Legislature, land managers, industry, Native corporations, and the public.

Alaska's metal and coal reserves
These numbers represent Alaska's ranking of coal and metal reserves relative to other countries worldwide.

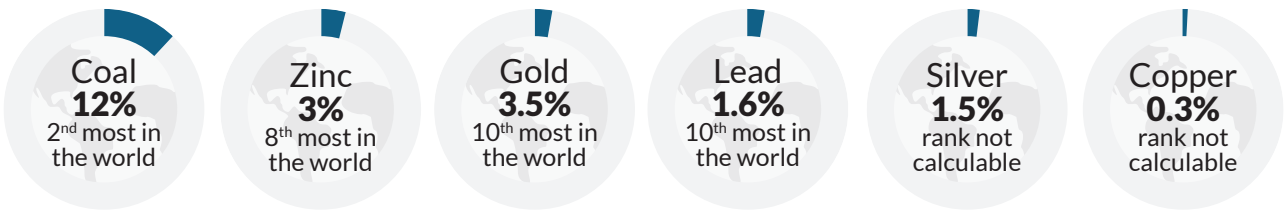


Table 1. Reported annual exploration and development expenditures of the mineral industry, the estimated theoretical first market value of mineral production in Alaska, and estimated revenue to the mineral industry from the sale of those commodities (in millions of dollars), 1981–2019. Average annual values are given for 1981–1985, 1986–1990, 1991–1995, and 1996–2000; individual year totals are provided for 2001–2019.

Year	Exploration Expenditures ($ millions)	Development Expenditures ($ millions)	Theoretical First Market Value ($ millions)[a]	Estimated Revenue to Industry ($ millions)[b]
1981–1985	$37.5	$36.3	$204.7	--
1986–1990	$36.2	$109.6	$288.6	--
1991–1995	$33.2	$55.3	$520.1	--
1996–2000	$49.4	$158.7	$917.4	--
2001	$23.8	$81.2	$917.3	--
2002	$26.5	$34.0	$1,012.8	--
2003	$27.6	$39.1	$1,000.7	--
2004	$70.8	$209.1	$1,338.7	--
2005	$103.9	$347.9	$1,401.6	--
2006	$178.9	$495.7	$2,858.2	--
2007	$329.1	$318.8	$3,367.0	--
2008	$347.3	$396.2	$2,427.1	--
2009	$180.0	$330.8	$2,455.6	--
2010	$264.4	$293.3	$3,126.8	--
2011	$365.1	$271.9[c]	$3,507.7	--
2012	$335.1	$342.4	$3,436.1	--
2013	$175.5	$358.8	$3,418.7	--
2014	$96.2	$281.7	$3,282.1	--
2015	$58.3	$309.9[c]	$2,759.2	--
2016	$58.9	$217.4	--	$2,536.6
2017	$120.8	$299.5	--	$2,724.7
2018	$140.1	$334.1	--	$2,428.1
2019	$171.0	$347.8	--	$2,530.0

Exploration, development, and production figures are provided in Alaska's Mineral Industry reports published annually by DGGS and sister agencies.

[a]Theoretical first market value is calculated by multiplying reported commodity amounts produced for a calendar year by the average yearly price per unit. This figure may significantly overestimate the value of the commodity, because it assumes that the commodity is a pure, final product and the operator has incurred no addtional charges during its production.

[b]Estimated revenue to industry is compiled from 1) revenue figures reported for the calendar year by major mine operators (accounting for actual sale prices and including smelting and refining charges and transportation costs), except a theoretical first market value is substituted when actual mine revenue is unavailable; 2) calculated value of industrial materials (rock, sand, and gravel) produced from some State and Federals lands (table 10); and estimated gross operating income of placer mining operations from Mining License Tax forms as reported by the Department of Revenue (table 11).

[c]2011 and 2015 total missing significant expected data

- - = Not reported

EMPLOYMENT

Total mineral industry employment in 2019 is estimated at 3,486 full-time-equivalent jobs, an overall increase of about 17 jobs from 2018, indicating little overall change in Alaska mineral industry employment (table 2). The exploration sector lost an estimated 54 jobs, down more than 14 percent from 2018. Exploration employment was estimated for 32 of 65 lode exploration projects using their reported exploration expenditure in conjunction with cost-per-project ratios averaged from 15 projects with complete employment data. Given the increase in 2019 exploration spending, the corresponding number of 2019 exploration jobs may be underestimated.

Development lost 16 jobs while production gained 87, a net gain of 71 positions (2 percent; photo 2). Changes in the number of development and production jobs likely reflect new hires at Alaska's mines and job reallocation from development to production at mine sites. Note that most large operators do not differentiate production from development employment; since 2014, development and production employment, when not specifically provided by the operator, have been estimated for large operations based on their reported ratio of production to development expenditures.

Placer employment has displayed a downward trend for seven years, and it is estimated that more than two-thirds of placer work (calculated as full-time equivalents) has been lost since the 2012 high. Yearly change in placer mining employment is unavailable for 2019, as data per reporting year from DOR has been shifted back a year to align the data more closely with the year of production, instead of the year in which the data were reported to DOR from operators. Placer mining employment in 2018 was estimated from the number of placer mines that reported gross operating income on Mining License Tax returns: a methodology fully explained in table 11. Placer mine employment is challenging to quantify due to the large number of small or seasonal operations, sole-proprietors, and family-based businesses.

Mine Safety and Health Administration (MSHA) data indicate that industrial materials production (rock, sand, and gravel) full-time-equivalent employment increased by almost 15 percent (35 jobs).[3] However, reported material-sale volumes decreased by a third in 2019. While materials-sector employment (and production volumes and values) are underreported, the MSHA dataset captures its employment more completely than past voluntary reporting through questionnaires.

This report relies on a variety of sources to tabulate mineral industry employment, including publicly available company documents, personal communications, and questionnaires sent out by DGGS. Many exploration companies and mine operators voluntarily responded to questionnaires with 2019 employment information. Affidavits of Annual Labor also provided 2019 employment data for hard-rock exploration projects. Additional employment information was obtained from MSHA. These datasets and sources represent a minimum estimate and an incomplete picture of mineral industry employment in Alaska, but the values that are available add to the statewide mining employment total and provide a more complete estimate of the impact of mining to the State's workforce and wealth-generation potential. Except for placer employment, full-time-equivalent positions are based on a 260-day work year and 10-hour workday unless actual average annual employment numbers are provided.

The Alaska Department of Labor and Workforce Development (DLWD) provided 2019 mining employment and wage statistics based

[3]Mine Safety and Health Administration, Employment/Production Data Set (dataset 9); last accessed November 30, 2020; arlweb.msha.gov/OpenGovernmentData/OGIMSHA.asp

on 121 reporting units (companies) consisting of 51 metal ore, 40 coal and nonmetallic-mineral quarrying, and 30 mining-support-activity units. Among companies in 2019, mining and support activities provided 3,243 jobs, up four percent from 3,110 jobs in 2018. Employment gains were almost equally distributed between the metal ore and coal and nonmetallic-mineral quarrying sectors. DLWD data show that nonmetallic-mineral-product manufacturing provided 226 jobs, which includes an average of 207 jobs in cement and concrete manufacturing for 2019. Primary metal manufacturing provided 14 jobs, while metal and mineral merchant wholesalers provided an average of 126 jobs during 2019.

According to DLWD data, 18 boroughs or census areas reported mining (excluding oil and gas) employment in 2019. Juneau, Anchorage, and Fairbanks area (combined Fairbanks North Star Borough and Southeast Fairbanks Census Area) accounted for almost 70 percent of mining employment in the State. In 2019, the Fairbanks area gained six new mining-related businesses employing 20 additional workers and had the highest number of mining jobs (1,219) among Alaska boroughs or census areas. The City and Borough of Juneau came in second with 863 jobs, up two percent from 842 jobs in 2018.

Wages for mining-sector jobs, averaging $110,434 in 2019, were some of the highest

Table 2. Estimated Alaska mineral industry employment, 2008–2019[a], as compiled from public documents, MSHA reporting[b], personal communications, and other sources. The total employment number for an operation may be divided among exploration, development, and production activities based on the reported expenditures in those categories.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gold/silver mining												
Placer[c]	282	399	405	439	477	432	241	224	222	193	192	159
Lode	739	832	1,008	1,085	1,206	1,176	1,054	1,047	1,253	1,193	1,132	1,174
Polymetallic mining	317	321	350	364	386	390	287	303	306	324	316	342
Base metals mining	475	413	550	586	530	550	446	475	526	606	482	502
Recreational mining	30	36	35	41	52	55	7	--	--	--	--	--
Industrial minerals								173	253	197	237	272
Sand and gravel	277	286	313	307	424	565	30	--	--	--	--	--
Rock	93	83	11	28	60	19	65	--	--	--	--	--
Coal[d]	110	117	140	140	144	120	115	112	100	89	99	96
Peat[d,e]	7	--	3	3	4	--	<1	--	--	--	--	--
Tin, jade, soapstone, ceramics, platinum	--	--	--	--	--	1	1	--	--	--	--	--
Production (total of above categories)	2,330	2,487	2,815	2,993	3,283	3,308	2,246	2,230	2,660	2,602	2,458	2,545
Mineral development	516	371	537	422	535	358	468	555	412	536	638	622
Mineral exploration	546	422	520	535[f]	548	385	253	116	160	254	373	319
Total	**3,392**	**3,280**	**3,872**	**3,950**	**4,366**	**4,051**	**2,967**	**2,901**	**3,232**	**3,392**	**3,469**	**3,486**

[a]Reported person-days are calculated on a 260-day work year and 10-hour work day to obtain average annual employment unless actual average annual employment numbers are provided.

[b]MSHA data: arlweb.msha.gov/OpenGovernmentData/DataSets/MinesProdYearly.zip

[c]See table 11 for updated information on placer employment calculations.

[d]Coal and peat employment numbers are combined in 2009.

[e]This figure does not include all of the person-days associated with peat operations; most of those person-days are included in sand and gravel numbers.

[f]Average of 520–550 range reported for 2011.

- - = Not reported

See Exploration, Development, and Production sections for further details.

Photo 2. Miner hard at work at Kensington mine in southeastern Alaska. Photo courtesy of Jan Trigg, Coeur Alaska, Inc.

among major industries in Alaska. However, the average mining-sector wage slipped two percent from $112,857 in 2018 while the average private-sector wage ($56,186) grew more than three percent over the previous year, slightly narrowing the huge disparity between these wages. Total wages paid by non-oil-and-gas mining firms in 2019 were $332,294,811, up more than two percent from 2018. Total wages paid by mining-support firms in 2019 were $23,809,676, a five percent decrease from 2018. DLWD employment data are based on wage records, and include part-time jobs but do not include the self-employed and working family members not covered under unemployment insurance. The majority of placer operators are self-employed and are therefore not counted in the DLWD data. Employment data may not include jobs in the exploration and development phases of mining at geological and engineering consulting firms that are categorized in the engineering, environmental, or construction industries. Consequently, mining's contributions to employment and earnings in Alaska are likely understated by DLWD's dataset.[4]

An in-depth report on the economic impact of the mining industry in Alaska, prepared by the McDowell Group for the Alaska Miners Association (AMA), estimates that in 2019 Alaska's mining industry provided 4,600 direct mining jobs and an additional 4,800 indirect jobs. Direct and indirect wages totaled an estimated $740 million. The McDowell report uses surveys and other research and analysis methods in an effort to include mining industry employment not captured by the DLWD and DGGS datasets. Mining employees, not including placer and materials production, live in more than 70 communities throughout Alaska.[5]

[4]State of Alaska Department of Labor and Workforce Development (DLWD), Research and Analysis Section, Quarterly Census on Employment and Wages (QCEW); last accessed February 8, 2021; live.laborstats.alaska.gov/qcew/ee19.pdf

[5]Alaska Miners Association, The Economic Benefits of Alaska's Mining Industry, February 2020; last accessed February 8, 2021; http://www.alaskaminers.org/economic-benefits

GOVERNMENT REVENUES FROM ALASKA'S MINERAL INDUSTRY

In 2019 government revenue from Alaska's mineral industry totaled $126.1 million (table 3). The 13 percent decrease from $144.7 million in 2018 is due primarily to less revenue from the State Corporate Income Tax, which is reported for the State fiscal year (FY 2019: July 1, 2018–June 30, 2019). Table 3 provides an itemized listing of estimated revenues paid to the State and municipalities. These revenues are incomplete and serve only as a minimum. Additionally, DNR reported that $52,715 were received in bond pool payments in 2019. Bond pool payments, which are reclamation financial assurance and not considered State revenue, may only be used to reclaim sites disturbed by mining activities.

State Corporate Income Tax (CIT) collections in FY 2019 declined 80 percent, continuing the trend of extreme variability in this State revenue stream. Lower base metal prices, particularly for zinc, led to lower tax collections from base-metal-producing Alaska mines in FY 2019. In addition, the FY 2019 tax collections number for mining CIT included some one-time impacts of prior-year refunds that reduced the net cash collection for the year. This is in contrast to the CIT revenue spike in FY 2018 that benefited from both higher zinc prices, likely leading to increased profitability and higher taxes paid by the companies, and the absence of one-time refunds.

Operators and royalty payees reported total gross income of $2.37 billion for mineral commodities that sold in tax year (TY) 2018 (December 1, 2017–November 30, 2018; table 4); this income is compiled from the Mining License Tax returns filed in TY 2019, and is the most recent figure available at the time of this report. Total gross income from mining activity that occurred in TY 2019 will be reported in the 2021 edition of this report. Total gross income from TY 2018 differs from the 2018 'estimated revenue to industry' of $2.4 billion in table 1, because the latter is compiled for the calendar year and includes some theoretical first market values of mineral production that may not have been sold during that time period, as well as the value of untaxed sand and gravel products. Table 4 also includes royalty-only taxpayers: royalty-only taxpayers are typically landowners who receive revenue solely from a royalty share with no gross income from mining operations. Table 4 is not directly comparable to previous versions of this table, which did not include royalty-only taxpayers. All major mines in Alaska earn gross income from mining operations and their income is included in the table's values. Income from Alaska's new Dawson mine will be included in the table beginning in the 2019 tax year.

Mining License Tax collections, which continued to rise slightly in FY 2019 (1 percent), were again variably impacted by volatile metal prices during the year (table 3). The Mining License Tax, unlike the Corporate Income Tax, does not have loss carryforward or carryback provisions, and therefore follows metal prices more closely. DOR reported that 401 taxpayers submitted Mining License Tax returns in TY 2019, of which 44 (11 percent) were liable for taxes on net taxable income from mining in the amount of $515.7 million (table 4). Negative net taxable incomes from mining, at an average loss of $514,996 per taxpayer, were reported by 133 taxpayers.

Revenue to municipalities rose in 2019 to $41.5 million (21 percent increase) over 2018. In Juneau, Fairbanks, and the Northwest Arctic Borough, revenue from mining-related activity was among the largest contributors to municipal and borough budgets. In addition, the mining industry paid almost $231 million to Native corporations, and Alaska communities received more than $1.3 million in charitable donations from the mining industry (photo 3).

Table 3. Reported and estimated revenues paid to the State of Alaska and municipalities by Alaska's mineral industry, 2014–2019. The figures in this table will change as data are reviewed and updated; the table has been significantly updated to reflect Department of Natural Resources and Department of Revenue reporting for previous years. See footnotes for reporting sources and dates.

		2014	2015	2016	2017	2018	2019
State mineral rents and royalties[a,b]							
State claim rentals		6,740,816	6,920,029	7,327,630	7,658,003	7,192,888	9,104,615
Production royalties[c]		7,004,376	4,608,137	2,816,884	3,125,925	2,472,558	797,152
Annual labor		389,807	321,419	331,986	374,244	392,085	438,098
Subtotal	**$**	**14,134,999**	**11,849,585**	**10,476,500**	**11,158,173**	**10,057,531**	**10,339,865**
State coal rents and royalties[b]							
Rents		315,398	351,724	347,324	268,866	231,159	223,799
Royalties[c]		2,514,532	2,430,267	2,237,777	2,232,394	1,971,999	2,519,086
Bonus		38,005	111,000	- -	- -	100	-100
Subtotal	**$**	**2,867,935**	**2,892,992**	**2,585,101**	**2,501,260**	**2,203,258**	**2,742,785**
State material Sales[b]							
Mental Health		115,493	69,163	25,130	24,366	50,558	15,144
Division of Land		10,559,857	11,293,545	6,412,271	4,637,844	4,540,134	6,734,784
State Pipeline Coordinator's Office		105,330	197,644	121,994	288,511	93,359	47,327
Subtotal	**$**	**10,780,680**	**11,560,352**	**6,559,395**	**4,950,720**	**4,684,051**	**6,797,255**
State mining miscellaneous fees[b]							
Filing fees		3,350	2,100	9,650	4,825	5,150	4,200
Bid Bonus		93,767	- -	193,963	- -	- -	- -
Penalty fees		122,035	43,307	95,677	220,770	91,920	135,611
Exploration incentive app filing fee		- -	- -	- -	- -	- -	- -
Surface mine investment interest		7,802	7,801	19,690	- -	- -	- -
Surface coal mining app fee		1,300	21,700	7,218	8,000	7,342	-653
APMA mining fees		26,511	24,302	21,627	21,302	29,024	66,171
Subtotal	**$**	**254,764**	**99,210**	**347,826**	**254,897**	**133,436**	**205,329**
Other Fees							
AIDEA - Facilities use fees[d]		11,986,000	11,356,000	10,709,000	10,014,951	9,081,619	8,129,483
State Fuel Taxes[e]		Not reported	Not reported	2,066,313	1,338,843	1,411,896	776,352
State corporate income tax[f]		15,215,598	17,320,051	1,636,850	-734,744	34,594,928	6,859,747
Mining License Tax[g]		23,457,300	38,665,209	11,131,203	41,525,192	47,297,409	47,777,544
Large Mine Permit Coordination Program Receipts[h]		1,919,659	1,725,021	1,364,952	968,827	928,035	991,271
State Total	**$**	**80,616,934**	**95,468,420**	**46,877,140**	**71,978,119**	**110,392,163**	**84,619,631**
Payments to Municipalities[i]		18,525,615	21,041,152	22,656,383	48,628,626	34,282,140	41,481,284
Total	**$**	**99,142,549**	**116,509,572**	**69,533,523**	**120,606,745**	**144,674,303**	**126,100,915**

[a] Includes upland lease and offshore lease rentals. Figures are reported by calendar year by the Alaska Department of Natural Resources.

[b] Figures are reported by calendar year by the Alaska Department of Natural Resources.

[c] Reported on a cash basis; payments actually received during the given year.

[d] AIDEA user fees for use of the State-owned roads and ports: the De Long Mountain Transportation System by Teck Alaska Inc., operator of the Red Dog mine; and for use of the Skagway Ore Terminal by Minto Explorations Ltd., a subsidiary of Pembridge Resources. AIDEA figures are reported by fiscal year.

[e] Values from 2016–2019 were reported by the major operating mines, less their fuel tax refund.

[f] Only subchapter C corporations pay income tax. This report may not reflect 100% of the returns received in a year. The amount of corporate income tax reported in each fiscal year is the amount of tax actually received and may not agree with the amount reported on a corporation's tax return. This is due primarily to timing differences.

[g] In 2012 and later, Mining License Tax was not collected on materials. Figures are reported by fiscal year. http://www.tax.alaska.gov/programs/programs/reports/AnnualData.aspx?60610

[h] The DNR, Office of Project Management and Permitting (OPMP) recovers costs from applicants for large mine permit coordination, per AS 38.05.020(b)(9) and AS 37.05.146(b)(3). Figures are reported by fiscal year.

[i] Payments to Municipalities include property taxes, payments in lieu of taxes (PILT), and severance taxes. Data should be considered a minimum estimate. Data were primarily provided by the major operating mines.

Table 4. Mining tax analysis by tax bracket for the 2016–2018 tax years, based on Mining License Tax returns. Analysis includes income from operations plus royalty income, including both royalty-only tax payers and those with both income from operations and royalty income. Information provided by the Alaska Department of Revenue. The figures in this table will change as data are reviewed and updated. Note yearly values reported by the Department of Revenue are adjusted to align with the production year.

Bracket	Marginal tax rate	No. of taxpayers	Total gross income	Net taxable income*	Net income as percentage of gross	Total tax liability	Average gross income	Average taxable income	Average tax liability
Tax Year 2016									
Under $0	0%	167	$169,089,549	$ -40,418,430	-24%	$0	$1,012,512	-$242,027	$0
$0 to $40,000	0%	262	$10,711,688	$1,337,360	12%	$0	$40,884	$5,104	$0
$40,001 to $50,000	3%	12	$794,735	$486,571	61%	$14,597	$66,228	$40,548	$1,216
$50,001 to $100,000	5%	16	$4,534,257	$1,123,283	25%	$40,164	$283,391	$70,205	$2,510
Over $100,000	7%	20	$2,600,226,828	$687,083,926	26%	$46,207,608	$130,011,341	$34,354,196	$2,310,380
Total		**477**	**$2,785,357,057**	**$649,612,710**		**$46,262,369**			
Tax Year 2017									
Under $0	0%	145	$170,883,000	$ -43,820,418	-26%	$0	$1,178,503	-$302,210	$0
$0 to $40,000	0%	245	$9,473,810	$1,207,899	13%	$0	$38,669	$4,930	$0
$40,001 to $50,000	3%	13	$1,434,394	$540,799	38%	$16,224	$110,338	$41,600	$1,248
$50,001 to $100,000	5%	20	$5,226,727	$1,351,991	26%	$47,600	$261,336	$67,600	$2,380
Over $100,000	7%	20	$3,243,156,732	$938,676,115	29%	$65,176,994	$162,157,837	$46,933,806	$3,258,850
Total		**443**	**$3,430,174,663**	**$897,956,386**		**$65,240,818**			
Tax Year 2018									
Under $0	0%	133	$678,261,482	$ -68,494,451	-10%	$0	$5,099,710	-$514,996	$0
$0 to $40,000	0%	224	$7,315,318	$1,087,285	15%	$0	$32,658	$4,854	$0
$40,001 to $50,000	3%	14	$654,845	$574,741	88%	$17,242	$46,775	$41,053	$1,232
$50,001 to $100,000	5%	14	$3,771,833	$991,149	26%	$35,557	$269,417	$70,796	$2,540
Over $100,000	7%	16	$1,677,483,551	$514,093,527	31%	$35,610,315	$104,842,722	$32,130,845	$2,225,645
Total		**401**	**$2,367,487,029**	**$448,252,251**		**$35,663,114**			

*Net income taxable under the Mining License Tax

Note: Taxpayers with negative income (under $0) are not a separate bracket, but are reported separately to distinguish between large money-losing operations and small operations with zero or positive income.

See page 7 for the differences between Total Gross Income (table 4) and the Estimated Revenue to Industry (table 1).

AMA's McDowell report on mining lists other benefits to the State that are not tracked in table 3.[5] In 2019, the Alaska Railroad Corporation received approximately $17.4 million from transportation of coal, sand, and gravel. McDowell estimates that Alaska's mining industry purchases goods and services from hundreds of Alaska vendors in support of operations.

Photo 3. Klawock High School students visit the Dawson mine on Prince of Wales Island. Photo courtesy of Robert Fithian, Sundance Mining Group LLC.

MINERALS-RELATED GOVERNMENT ACTIVITIES

U.S. Geological Survey

The U.S. Geological Survey (USGS) Mineral Resources Program had multiple projects focused on the geologic framework and mineral resources of Alaska in 2019. Alaska Science Center research staff in Anchorage conducted field-based studies of the tectonic and metallogenic evolution of the Yukon–Tanana uplands, eastern Alaska, and on the geological framework of the Taku River watershed, southeastern Alaska. Field work in the Taku River drainage focused on porphyry-style mineralization in the area as part of a regional characterization of transboundary watershed geology and mineral potential.

Research staff at the Geology, Geophysics, and Geochemistry Science Center (G3) in Denver completed an exploration geochemistry study near the Taurus porphyry copper deposit in eastern interior Alaska. The purpose is to identify potential indicator minerals in stream sediments and assess the utility of indicator minerals and hydrogeochemistry in this part of Alaska. A journal article on the hydrogeochemistry is in review. A data release of all data from this effort is in Kelley and others (2020, doi.org/10.5066/P94KBWD3). G3 staff continued to conduct placer gold provenance studies, with characterization of populations of gold particles according to both alloy compositions and suites of mineral inclusions (microchemical characterization) on samples from the Fortymile and Fairbanks districts.

Following the successful GIS-based evaluation of critical mineral potential in Alaska in 2016, research staff in Anchorage and Denver mapped the potential for lode gold associated with porphyry, reduced intrusion-related, epithermal, and orogenic deposits. Another similar report was completed for sediment-hosted Pb–Zn deposits in Alaska. Additional geochemical and geophysical datasets were added to the analysis to help reduce uncertainty in the evaluation rankings. Work continued on improving and adapting the evaluation method for sediment-hosted copper, volcanogenic massive sulfide (VMS), and porphyry copper deposits. A topical study of the Graphite Creek deposit, Seward Peninsula, was commenced to develop a geological model and salient criteria to be used for GIS analysis of regional flake graphite potential. Also, a USGS three-part mineral resource assessment was completed for tungsten skarn deposits in the Yukon–Tanana uplands (photo 4). A quantitative assessment was conducted in the vicinity of Fairbanks, and a qualitative assessment was done for the rest of the uplands.

Finally, research staff from Anchorage and Denver participated in national science planning for the USGS Earth Mapping Resource Initiative (Earth MRI) and developed multiple Alaska focus areas that have critical mineral potential and require new geological mapping and geophysical data acquisition.

Photo 4. U.S. Geological Survey geologist at work in the Yukon–Tanana uplands during the 2019 Earth MRI project. Photo courtesy of the USGS.

U.S. Bureau of Land Management

The U.S. Bureau of Land Management (BLM)–Alaska administers and adjudicates all Federal mining claim locations in Alaska, manages mining and other activities on BLM-managed lands, and continues its mission to convey land to the State of Alaska as well as Alaska Native village and regional corporations. Annually, the BLM conveys thousands of acres of land to the State and Native corporations under the authority of the Alaska Statehood Act and the Alaska Native Claims Settlement Act (ANCSA); most of the conveyed State land is open to claim location.

In early 2019, the Department of the Interior issued Public Land Orders revoking land withdrawals established in Section 17(d)(1) of the Alaska Native Claims Settlement Act that had prevented the potential selection and conveyance of 1.3 million acres of Federal land to Native Corporations and the State of Alaska. These lands were in the Fortymile River and Bering Glacier regions. Where lands were not selected by the State or Native Corporation, the revocation of the withdrawals opened lands to the location of mining claims and mineral development. As of 2020, some townships have been conveyed to the State and Native Corporations but there have been no mining claims yet located on the newly opened lands.

The John D. Dingell, Jr. Conservation, Management, and Recreation Act was passed in March 2019. It is a broad public lands law directing land conveyances and exchanges of public lands, funding for the Land and Water Conservation Fund, expansion of existing national parks, and establishment of new national monuments. In Alaska, the impacts include new opportunities for Alaska Native Vietnam-era Veterans or their heirs to apply for allotments of public land. The act also allows mining claim owners the opportunity to fix errors in required annual claim filings and finally, the act reinstated several closed Federal mining claims in Alaska.

In the summer of 2019, BLM Alaska issued instructional memoranda to the BLM field staff regarding how to address revegetation on reclaimed lands and how to assess stream reclamation. Additional guidance was issued on conducting compliance inspections and how to record, document, and communicate the results of mining inspections. All of these policies were developed to expedite and clarify BLM management practices so miners have clearer expectations and understanding of how BLM-managed lands and their operations will be managed.

In 2019 Alaska was again the home of a BLM Reclamation and Sustainable Mineral Development Award winner. The Race family (DBA Goldnuts, LLC) won the national reclamation award in the Small-Operator category. The Race family mining operation was recognized for their progressive approach to stream reclamation in the Fortymile Wild and Scenic River area of Alaska. They continue to improve upon traditional reclamation practices in order to accelerate both wildlife and fisheries habitat recovery. They have also supported neighboring operations in their reclamation efforts.

BLM Alaska continues its inventory and assessment of closed Federal mining claims in preparation for those lands to be conveyed to the State and Native Corporations. BLM staff and private contractors are going through closed casefiles to locate closed claims and have been conducting field inspections to determine if lands are either free of encumbrances or they are documenting any pre-existing disturbances or property. Clean up plans are being developed for any documented reclamation liabilities.

Finally, the BLM has funded the DGGS to expand their gravel and construction material assessment of the North Slope. This cooperative agreement will produce, in 2021, an estimate of the location, volume, and character of materials necessary for energy industry developments on the North Slope.

Division of Mining, Land and Water

The Division of Mining, Land and Water (DMLW) manages mineral exploration and development on more than 96 million acres of State land in Alaska. In addition, the Division reviews and approves the operation and reclamation plans for mining projects, including coal, on all State, Federal, and private lands in Alaska. In 2019, the Division's Large Mine Permitting Team coordinated hard rock mine permitting activities at Red Dog, Fort Knox, Pogo, Kensington, Greens Creek, and Nixon Fork (photo 5).

Advanced exploration projects active in 2019 include, but are not limited to, Donlin Gold in southwestern Alaska, Pebble project near Iliamna, Graphite Creek project on the Seward Peninsula, Palmer project near Haines, Livengood Gold project in the Tolovana Mining District, and Upper Kobuk Mineral Projects at Arctic and Bornite. Regional exploration efforts in the Goodpaster Mining District near Pogo mine and the western Alaska Range also ramped up in 2019. DMLW manages mineral exploration and placer mining through the Application for Permits to Mine in Alaska (APMA). In 2019 there were 536 operations with active APMAs. Of these operations, 371 were for placer mining and exploration, 64 were for hard rock exploration, and 101 were for suction dredging activities.

The State regulates coal mining through the Coal Mining Regulatory program. In addition to inspection and permitting of ongoing mining and reclamation at the Usibelli Coal Mine operations in Healy and inspection of inactive operations in the Wishbone Hill area, 2019 saw continued interest in coal exploration in the Canyon Creek area south of Skwentna.

The State Abandoned Mine Lands Program (AML) for the past seven years has been actively reclaiming legacy coal mines that were

Photo 5. Division of Mining, Land and Water staff observe core sampling of the drystack at Pogo mine in interior Alaska. Photo courtesy of Jenny March, DMLW.

left abandoned in the Healy Valley. Most recently the program completed the Vitro pit, which eliminated 2,200 feet of highwall that in places exceeded 140 vertical feet. The project took three years to complete, regrading 700,000 cubic yards of material at a cost of nearly $5.1 million. AML is now focused on reclaiming the Cripple Creek pit, which will be accomplished in two separate phases. Phase I will run from August of 2020 through the early summer of 2022. Phase II will begin as early as 2022. The AML program will remain active in the Healy Valley for at least the next 10 years.

Division of Geological & Geophysical Surveys

Alaska Geologic Materials Center

The Alaska Geologic Materials Center (GMC), curated and operated by DGGS, is the State's largest and most comprehensive archive of geologic samples (photo 6). The GMC houses drill core from numerous Alaska mineral prospects, DGGS rock samples, and the Alaska collections of the U.S. Geological Survey, the former U.S. Bureau of Mines, and other agencies.

Sample donations to the 100,000-square-foot facility at 3651 Penland Parkway in Anchorage have pushed space taken up by the total collections to over half-full. The new facility features comfortable viewing areas with roller tables and high-lumen overhead lighting (photo 7). The sample preparation room contains 14" and 20" slabbing saws. The GMC tracks 700,000 samples, including 38,739 core boxes from 277 prospects representing 2,242 boreholes. The browser-based search interface (maps.dggs.alaska.gov/gmc) allows users to build simple to complex queries through text- or map-based searches to find samples of interest. Significant donations in 2019 included exploration records and minerals collections from Stevens Exploration.

Photo 6. The Geologic Materials Center connects the State's largest geologic collections to research, industry, and education communities for the purposes of greater geologic understanding and increased awareness of economic opportunities. Photo courtesy of Kurt Johnson, DGGS.

Photo 7. A June 2019 GMC workshop presented non-destructive rock scanning technologies to over 80 attendees. A subsequent survey indicated strong industry, agency, and academic support for hyperspectral scanning, high resolution photography, petrophysical property scanning, X-ray fluorescence, and automated thin section scanning. Photo courtesy of Kurt Johnson, DGGS.

Mineral Resources Section Activities

The DGGS Mineral Resources Section uses its expertise in mineral deposit geology, geophysics, and geochemistry to evaluate State land for its potential to host undiscovered mineral resources (table 5). Section staff conduct geophysical surveys, geologic mapping, mineral-resource assessments, and ore deposit research; they also track mineral industry exploration and discoveries, development, and production. Additionally, the Section's expertise and knowledge are utilized to review other Departmental actions, including State land selection conveyance prioritization, land-use plans, land

Table 5. New mineral resource-related DGGS publications in 2019.

Geologic maps, reports, and geochemical data
The Mineral Resources section at DGGS (Information Circular) – doi.org/10.14509/30158
Geologic map of the Alaska Highway corridor, Dot Lake to Tetlin Junction – doi.org/10.14509/30037
Geologic map of the Alaska Highway corridor, Tetlin Junction to Canada border – doi.org/10.14509/30038
Geologic map of the Alaska Highway corridor, Little Gerstle River to Dot Lake – doi.org/10.14509/30036
Eastern Tanacross project geochemical data – doi.org/10.14509/30267
Northeast Tanacross project U-Pb geochronology report – doi.org/10.14509/30198
Moran project Ar/Ar geochronology data – doi.org/10.14509/30117
Alaska's mineral industry 2018 (report) – doi.org/10.14509/30227
Alaska's mineral industry in 2018 (presentation) – doi.org/10.14509/30164
Bonnifield mining district petrography database – doi.org/10.14509/30171
Radon testing after earthquakes – doi.org/10.14509/30168
Naturally occurring radon in Alaska – doi.org/10.14509/30163
Naturally occurring asbestos in Alaska – doi.org/10.14509/30162
Geophysical surveys
Porcupine River area aeromagnetic survey – doi.org/10.14509/29737
Geophysical surveys re-released in modern digital formats

Aniak – doi.org/10.14509/30221
Beaver Creek – doi.org/10.14509/29821
Black Mountain – doi.org/10.14509/29756
Circle – doi.org/10.14509/30167
Council – doi.org/10.14509/30172
East Richardson – doi.org/10.14509/29754
Fairbanks – doi.org/10.14509/30230
Farewell – doi.org/10.14509/30190
Fox Hills – doi.org/10.14509/29820
Goodpaster – doi.org/10.14509/29813
Iditarod – doi.org/10.14509/30222
Liscum – doi.org/10.14509/29755
Middle Styx – doi.org/10.14509/30188
Moran – doi.org/10.14509/30201
Nome – doi.org/10.14509/30189
Northeast Fairbanks – doi.org/10.14509/30062
Nyac – doi.org/10.14509/30169
Salcha River-Pogo – doi.org/10.14509/30179
Southeastern extension of Salcha River-Pogo – doi.org/10.14509/30185
Slate Creek-Slana River –doi.org/10.14509/29852
Sleetmute – doi.org/10.14509/30223
Southern Delta River – doi.org/10.14509/30229
Southern Dishna River – doi.org/10.14509/29819
Styx River – doi.org/10.14509/30166
Valdez Creek – doi.org/10.14509/30170
Western Fortymile – doi.org/10.14509/30178
Wrangellia – doi.org/10.14509/29848

disposal actions, review of Federal actions, and infrastructure planning. The geophysical, geological, and resource surveys conducted by the Mineral Resources Section not only inventory the potential for mineral resources but add value to the State's current and future revenue.

Since 1993 the data products of the Airborne Geophysical/Geological Mineral Inventory (AGGMI) program have been an important component of successful resource-exploration programs; products have contributed to the private-sector discovery of more than 22 million ounces of gold resources in the Salcha River–Pogo and Livengood areas (fig. 2). State budget cuts impacted the AGGMI program, resulting in the loss of a permanent staff position in the Mineral Resources Section and decreases in its annual funding for data collection and publication. New geophysical surveys now rely on funding from external sources or the State of Alaska capital budget.

Geophysical Datasets

In 2019 no new airborne geophysical data were collected by DGGS. All "modern" airborne geophysical surveys managed by DGGS have been archived, updated, and are available online at dggs.alaska.gov/geophysics/get-data.html. Existing airborne geophysical data coverage is shown in figure 2. In 2019 DGGS received $500,000 from the USGS Earth MRI program to collect fixed-wing magnetic and radiometric data in the Yukon–Tanana uplands. DGGS anticipates a multiyear program to achieve full magnetic data coverage of the Yukon–Tanana uplands.

Geologic Mapping and Geochemical Sampling

In 2019 DGGS Mineral Resources geologists completed fieldwork for a 1,860-square-mile geologic map of the eastern Tanacross Quadrangle, Alaska's first geologic mapping project initiated under the U.S. Geological Survey's Earth Mapping Resources Initiative (Earth MRI). The newly created Earth MRI program funds new geologic mapping of areas that are prospective for discovery of strategic and critical minerals (photo 8). The Mineral Resources section also published four new bedrock geologic maps of the eastern Interior region in 2019, including the 2,016-square-mile Alaska Highway corridor map series and the preliminary version of the Northeastern Tanacross geologic map.

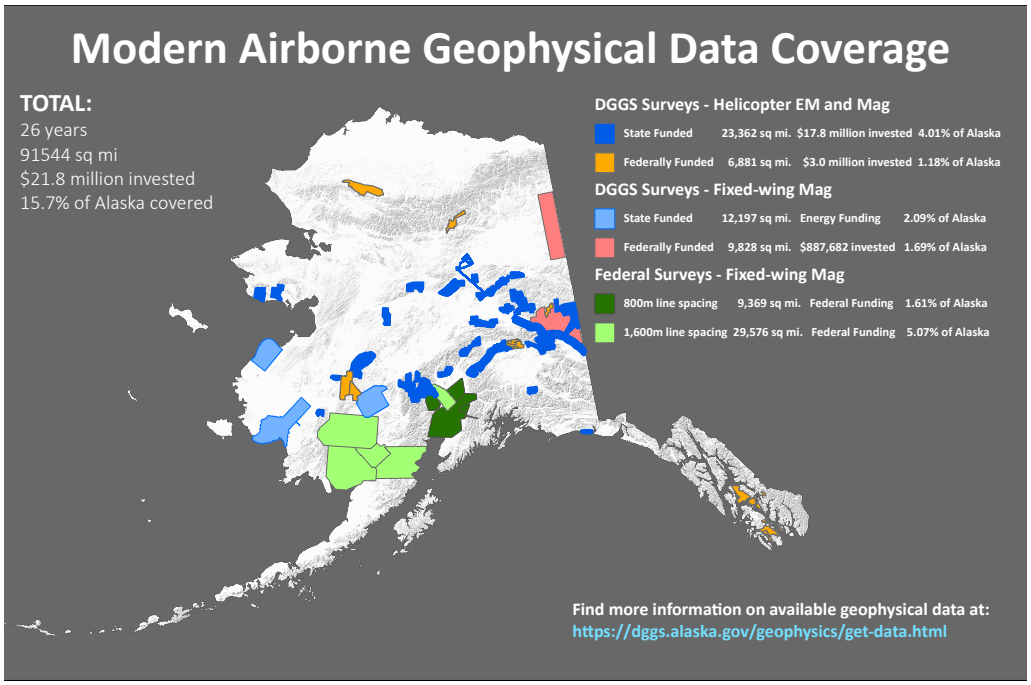


Figure 2. Modern airborne geophysical data coverage of Alaska, managed by Alaska Division of Geological & Geophysical Surveys and the U.S. Geological Survey over the past 26 years. Survey data are available from the Division's website: maps.dggs.alaska.gov/gp/.

Photo 8. DGGS Intern Julian Lopez mapping in the eastern Tanacross Quadrangle of interior Alaska in 2019. Photo courtesy of Karri Sicard.

EXPLORATION

Industry again displayed interest in exploring Alaska's mineral resource endowment in 2019 (fig. 3): an endowment described as "blessed" by Northern Star Resources President Bill Beament, one of the growing number of Australian companies working in the State.[6] Exploration spending increased in 2019 to $171.0 million, rising 22 percent and contributing to the climbing four-year trend since exploration budgets bottomed out in 2015 (fig. 4). In contrast, the global exploration budget decreased three percent overall—Alaska's share of the $9.8 billion global exploration budget increased to 1.7 percent.[7] Globally, exploration in 2019 was hampered by geopolitical and macroeconomic issues and uncertainty, such as the trade dispute between China and the U.S., which caused many commodity prices to dip. Other factors challenging worldwide exploration budgets included merger and acquisition activity among major companies and volatile availability of financing.[8]

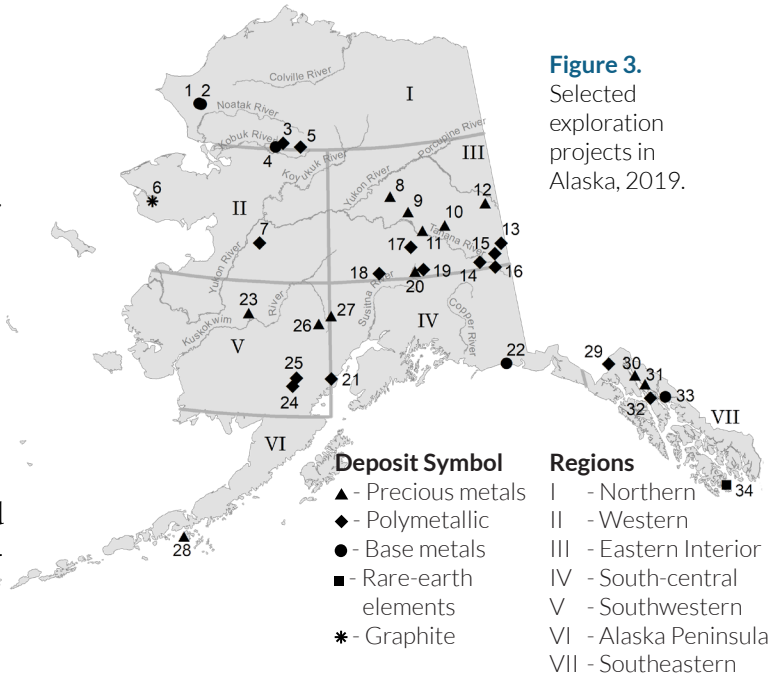


Figure 3. Selected exploration projects in Alaska, 2019.

Exploration

I. Northern Region

1. Lik—Solitario Zinc Corp. / Teck
2. Aŋarraaq-Aktigiruq —Teck
3. Arctic—Ambler Metals LLC
4. Bornite—Ambler Metals LLC
5. Sun—Valhalla Metals Inc.

II. Western Region

6. Graphite Creek—Graphite One Inc.
7. Illinois Creek—Western Alaska Copper & Gold

III. Eastern Interior Region

8. Tolovana District
   a. Livengood—International Tower Hill Mines Ltd.
   b. Shorty Creek—Freegold Ventures Ltd.
9. Fairbanks District
   a. Fort Knox and district—Kinross Gold Corp.
   b. Amanita—Avidian Gold
10. Goodpaster District
    a. Pogo mine area—Northern Star Resources Ltd.
    b. 64North Gold Project—Millrock Resources-Resolution Minerals
    c. Tibbs—Tectonic Metals Inc.
    d. Healy Claims—Northway Resources Corp.
11. Richardson Subdistrict
    a. Sam—GAME
12. Seventymile—Tectonic Metals Inc.
13. Tanacross—Kenorland Minerals
14. Oreo Mountain—Tubutulik Mining Company LLC
15. Peak—Peak Gold LLC
16. Northway—Tectonic Metals Inc.
17. Red Mountain—White Rock Minerals Ltd.
18. Golden Zone—Avidian Gold Inc.
19. Alaska Range Project—PolarX Ltd.
20. Valdez Creek Lode—Valdez Creek Mining LLC

IV. South-central Region

21. Johnson Tract—HighGold Mining Inc.
22. Icy Cape—Alaska Mental Health Trust Land Office

V. Southwestern Region

23. Donlin Gold—Donlin Gold LLC
24. Pebble—The Pebble Limited Partnership
25. Groundhog—Quaterra Resources-Chuchuna Minerals
26. Terra—WestMountain Gold Inc.
27. Estelle—Nova Minerals Ltd.

VI. Alaska Peninsula Region

28. Unga—Redstar Gold Corp.

VII. Southeastern Region

29. Palmer—Constantine Metal Resources Ltd.
30. Kensington—Coeur Alaska Inc.
31. Herbert Gold—Grande Portage Resources Ltd.
32. Greens Creek Mine—Hecla Mining Company
33. Snettisham—Resolution Minerals Ltd.
34. Bokan Mountain—Ucore Rare Metals Inc.

[6]Fraser Survey: Alaska shines, Canada slips, North of 60 Mining News, March 1, 2020. www.miningnewsnorth.com/story/2020/03/01/news/fraser-survey-alaska-shines-canada-slips/6186.html

[7]World Exploration Trend 2019: PDAC Special Edition, S&P Global Market Intelligence, March 2020. go.snapapp.com/world-exploration-trends-2019

[8]2019 exploration budget recovery falters due to difficult market conditions and high-profile M&A activity, PRNewswire, October 15, 2019. www.prnewswire.com/news-releases/2019-exploration-budget-recovery-falters-due-to-difficult-market-conditions-and-high-profile-ma-activity-300938552.html

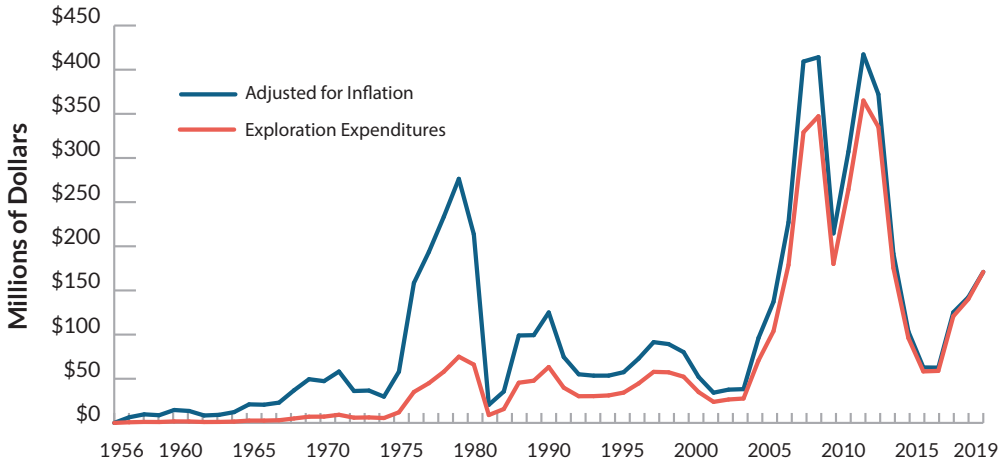
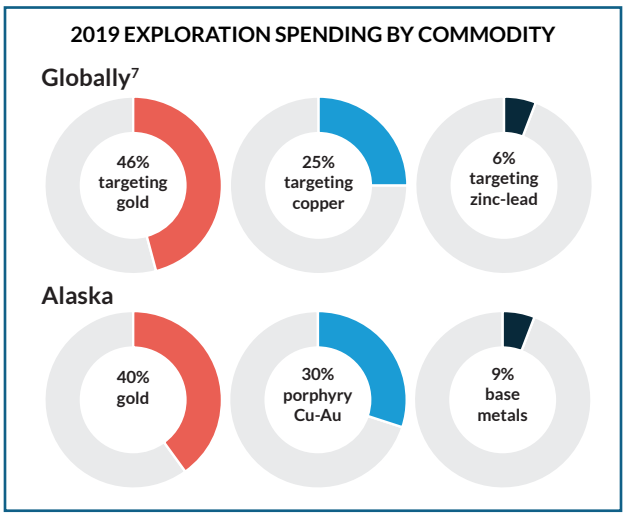


Figure 4. Alaska mineral exploration expenditures, 1956–2019. Blue line is adjusted for inflation to 2019 dollars.

Alaska exploration budgets by commodity and deposit type generally followed global trends, but with a more healthy spin on each sector due to increased 2019 exploration spending in the State. Expenditures on gold, massive sulfide, and platinum-group-element targets stayed relatively flat (table 6; fig. 5). A different company data source used in 2019 accounts for the majority of an apparent $32 million (158 percent) jump in exploration spending on Alaska porphyry (Cu–Au±Mo) targets. Exploration budgets targeting less common deposit types, including critical mineral targets, rose a more modest 21 percent. By comparison, global copper- and base-metal-target budgets increased, but not enough to compensate for decreased spending on gold targets.[7]



Sixty-four lode mineral exploration projects, some managed by the same company, reported activity in 2019. About a third of Alaska's exploration budget ($58 million) was spent on 52 early-stage exploration projects, while globally, a quarter of exploration funding went to greenfields.[7] Eight Alaska advanced-exploration projects and projects in the permitting stage spent almost half of the exploration budget (48 percent), as compared to 33 percent of global late-stage exploration expenditures.[7] Minesite exploration dropped two percentage points to 18 percent, although some Alaska mines are also exploring for new resources farther afield than their immediate minesites. Globally, 2019 minesite exploration exceeded the other stages' expenditures for the first time.[7] Excluding Alaska's operating mines, 18 projects spent $1 million or more, totaling $132.5 million. An additional 19 projects each spent $100,000 or more.

The 2019 Fraser Institute study assessed factors related to policy and permitting that affect exploration decisions in Canada, the U.S., and Australia.[2] Alaska improved its Policy Perception Index ranking, an assessment of the attractiveness of mining policies in a jurisdiction, from 26th (of 83) in 2018 to 17th (of 76) in 2019. Managers and executives expressed fewer concerns about uncertainty around mining-related regulations, such as environmental regulations and protected lands. **All mining companies working in Alaska who responded to the Fraser Institute survey were able to obtain their exploration permits in six months or less, were confident they would receive their permits, and indicated no concerns with process transparency.**

Table 6. Reported exploration expenditures in Alaska by commodity, 1981–2019. All 2019 exploration expenditures were reported by the company; no estimates were utilized in the compilation.

	Base metals	Polymetallic[a]	Precious metals[b]	Industrial minerals	Coal and peat	Other[c]	Total
1981	$ 28,262,200	- -	$ 35,273,200	$ 10,300,000	$ 2,341,000	$ 127,000	$ 76,303,400
1982	31,757,900	- -	10,944,100	- -	2,900,000	15,300	45,617,300
1983	9,758,760	- -	20,897,555	2,068,300	1,338,454	70,000	34,133,069
1984	4,720,596	- -	14,948,554	270,000	2,065,000	279,500	22,283,650
1985	2,397,600	- -	6,482,400	- -	270,000	- -	9,150,000
1986	1,847,660	- -	6,107,084	170,000	790,000	- -	8,914,744
1987	2,523,350	- -	11,743,711	286,000	1,150,000	31,000	15,734,061
1988	1,208,000	- -	41,370,600	160,200	2,730,000	- -	45,468,800
1989	3,503,000	- -	43,205,300	125,000	924,296	5,000	47,762,596
1990	5,282,200	- -	57,185,394	370,000	321,000	97,000	63,255,594
1991	4,789,500	- -	34,422,039	92,000	603,000	2,000	39,908,539
1992	1,116,000	$ 3,560,000	25,083,000	25,000	425,000	0	30,209,000
1993	910,000	5,676,743	23,382,246	163,500	0	125,000	30,257,489
1994	600,000	8,099,054	18,815,560	225,000	2,554,000	810,000	31,103,614
1995	2,770,000	10,550,000	20,883,100	100,000	0	3,000	34,306,100
1996	1,100,000	11,983,364	31,238,600	400,000	0	0	44,721,964
1997	1,700,000	22,347,000	32,960,500	80,000	720,000	0	57,807,500
1998	1,000,000	13,727,000	42,441,000	12,000	87,000	0	57,267,000
1999	3,869,000	3,168,000	44,891,000	1,000	0	410,000	52,339,000
2000	8,545,000	3,933,000	21,579,000	58,500	0	736,100	34,851,600
2001	4,810,000	1,977,000	15,820,000	50,000	10,000	1,106,000	23,773,000
2002	1,700,000	5,162,000	17,342,000	185,000	0	2,113,000	26,502,000
2003	262,000	7,081,000	19,726,000	0	0	533,000	27,602,000
2004	3,100,000	40,237,000	26,954,000	213,000	50,000	258,000	70,812,000
2005	1,764,000	54,271,000	46,255,000	142,000	0	1,463,000	103,895,000
2006	5,069,000	81,073,000	89,793,000	20,000	2,394,000	580,000	178,929,000
2007	38,888,000	123,487,500	155,601,400	42,500	7,675,000	3,447,000	329,141,400
2008	30,116,000	163,030,000	134,885,000	0	0	19,238,000	347,269,000
2009	3,862,715	85,871,529	84,020,531	17,850	0	6,193,518	179,966,143
2010	6,392,519	122,955,321	125,364,382	19,000	6,520,200	3,104,199	264,355,621
2011	7,730,891	160,880,974	186,255,005	- -	3,250,000	6,962,325	365,079,195
2012	18,161,211	150,339,009	152,444,311	- -	W	14,129,838	335,074,369
2013	8,122,810	103,524,782	60,977,949	22,762	W	2,840,713	175,489,016
2014	8,310,433	29,836,240	51,759,541	32,221	W	6,300,413	96,238,848
2015	6,199,064	25,171,955	26,907,877	- -	- -	- -	58,278,896
2016	7,820,283	25,295,705	24,857,804	- -	- -	912,510	58,886,302
2017	16,207,528	48,325,468	53,605,626	- -	W	2,669,363	120,807,985
2018	11,932,106	57,693,015	66,168,235	- -	W	4,278,600	140,071,956
2019	16,109,000	80,523,572	69,023,716	- -	W	5,320,390	170,976,678
Total	**$ 314,218,326**	**$ 1,449,780,231**	**$ 1,951,615,320**	**$ 15,650,833**	**$ 39,117,950**	**$ 84,160,769**	**$ 3,854,543,429**

[a]Polymetallic deposits considered a separate category for the first time in 1992.

[b]Approximately $0.94 million spent on platinum-group-element (PGE-Ni-Cu) exploration during 2014, included in the polymetallic category. Prior to 2013, PGE exploration was included in the precious metal exploration total.

[c]Includes rare-earth elements, magnetite sands, graphite, and other common deposit types.

N/A = Not available

- - = Not reported

W = Withheld; data included in "Other" column

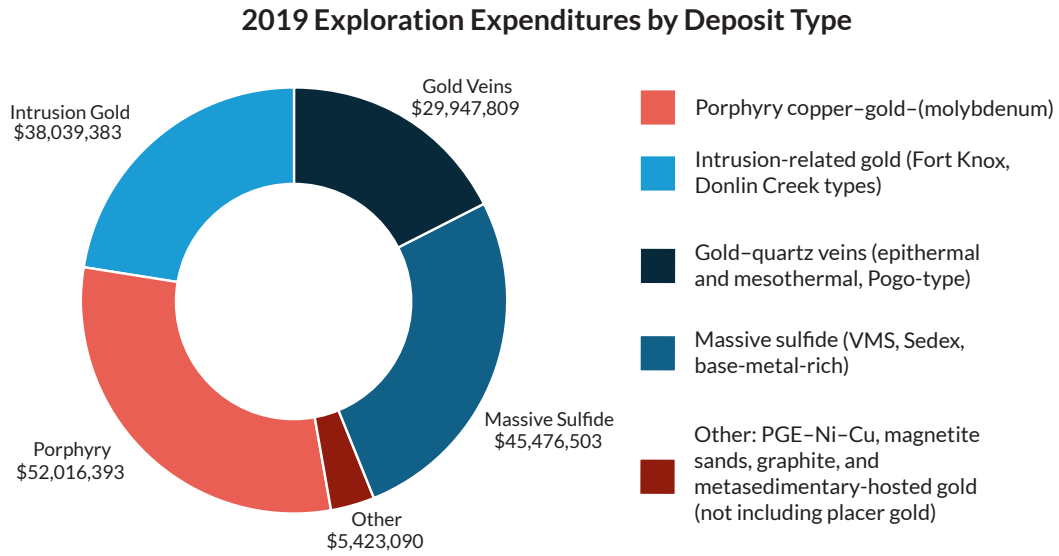


Figure 5. Exploration expenditures by deposit type, 2019.

The total area of the State covered by mining claims and prospecting sites in 2019 decreased by more than seven percent to over 3.5 million acres (table 7). The total inventory of 40- and 160-acre claims decreased by three percent and nine percent, respectively, while State prospecting sites increased by 16 percent. Although the total acreage decreased, 51 percent more new 160-acre claims and more than three times as many State prospecting sites were staked in 2019 compared to 2018.

Northern Region

Aŋarraaq–Aktigiruq

Teck Alaska Inc. continued to explore for sediment-hosted massive sulfides at their Aŋarraaq deposit and Aktigiruq prospect, about eight miles northwest of Red Dog mine. Work in 2019 consisted of 22,378 feet of core drilling in 18 holes, including six holes completed using direction drilling from two pad locations. Other work included geologic mapping, rock sampling, and ground gravity surveying. The Aŋarraaq deposit holds an inferred resource of 21 million tons grading 14.4 percent zinc, 4.2 percent lead, and 2.13 ounces of silver per ton (appendix D). At the nearby Aktigiruq exploration target, exploration drilling suggests a potential resource in the range of 88–165 million tons of mineralization grading 16–18 percent combined zinc plus lead. If confirmed, Aktigiruq would be one of the largest undeveloped zinc deposits in the world, comparable in total size to all past production and current reserves at Red Dog mine.

Lik

Teck and 50 percent co-owner Solitario Zinc Corp. resumed exploration at the Lik zinc–lead–silver sediment-hosted massive sulfide deposit northwest of Red Dog mine. Lik hosts two massive sulfide deposits with a total indicated and inferred resource of 25.85 million tons grading 8.23 percent zinc, 2.72 percent lead, and 1.16 ounces of silver per ton (appendix D). The 2019 field exploration program, managed by Teck, consisted of geologic mapping and geochemical sampling over a portion of the property.

Ambler Mining District

Upper Kobuk Mineral Projects

In December 2019, South32 Limited announced that it had exercised its option to acquire a 50 percent interest in the Upper Kobuk Mineral Projects (UKMP) from partner Trilogy Metals Inc. Trilogy will contribute its UKMP assets to the new joint venture company, Ambler Metals LLC, and South32 will contribute $145 million.

In 2017, the Alaska Industrial Development and Export Authority (AIDEA) began the permitting process under the National Environmental Policy Act (NEPA) for an approximately 211-mile-long industrial access road into the

Table 7. Summary of claim activity, 1991–2019.

	State Claims				State Prospecting Sites (160 acres)		Federal Claims (20 acre sites)	
Year[a]	New (Active) 40 acre[b]	New (Active) 160 acre	Total (Active) 40 acre[b]	Total (Active) 160 acre	New	Total	New	Total
1991	3,277	0	37,862	0	747	1,723	1,299	23,222
1992	2,640	0	36,250	0	454	1,472	695	20,254
1993	2,120	0	34,340	0	1,412	2,259	601	9,298
1994	4,057	0	34,400	0	802	2,378	341	8,495
1995	4,512	0	30,464	0	1,030	2,725	376	7,766
1996	9,489	0	36,602	0	2,082	3,687	681	9,346
1997	8,678	0	42,836	0	2,480	5,305	1,872	11,320
1998	9,786	0	49,816	0	3,194	7,148	427	11,033
1999	11,978	0	56,107	0	1,755	7,600	308	10,176
2000	4,560	614	54,393	614	1,143	5,675	523	7,805
2001	858	907	49,627	1,503	27	3,091	464	8,248
2002	745	826	44,056	2,179	61	2,138	261	8,100
2003	856	2,603	38,076	4,387	101	1,857	676	8,424
2004	1,070	3,533	34,380	7,719	59	1,484	66	8,313
2005	806	4,502	34,066	11,551	128	1,612	411	7,826
2006	1,111	5,747	33,864	16,249	103	1,646	457	8,068
2007	576	6,031	31,305	20,208	57	1,625	933	8,872
2008	1,333	2,565	23,033	13,519	24	651	3,001	11,732
2009	1,142	2,793	24,340	16,381	40	335	1,057	10,431
2010	1,446	6,132	24,805	20,389	88	441	332	8,413
2011	1,932	4,893	24,319	21,970	180	273	284	8,438
2012	1,638	3,478	24,673	20,810	202	409	632	- -
2013	1,622	2,155	24,883	17,347	28	209	289	6,916
2014	1,219	677	25,479	15,250	19	197	69	6,003
2015	1,014	711	26,493	15,961	21	36	71	6,074
2016	1,164	893	21,303	9,887	21	31	37	5,656
2017	1,713	3,453	22,175	12,074	44	85	695	6,259
2018	1,083	2,319	19,757	17,948	23	113	87	6,248
2019	1,063	3,508	19,245	16,303	90	131	85	6,229

Information provided by Alaska Department of Natural Resources and U.S. Bureau of Land Management. The figures in this table will change as data are reviewed and updated.

[a]After 2010, State claim and prospecting site totals are not directly comparable to previous years. After 2016, new State prospecting sites and total prospecting sites are not directly comparable to previous years.

Claim totals comprise Mining Claims (including "River Bottom Navigable" subtype) and Leasehold Locations whose claimants filed an Annual Affidavit of Labor, and claims initiated on State-selected land. There were 70 active 40-acre claims and 90 active 160-acre claims on State-selected land in 2019, as compared with 90 active 40-acre claims and 54 active 160-acre claims on State-selected land in 2018.

[b]Includes claim fractions varying from 1 to 39 acres.

- - = Not reported

Ambler Mining District to be funded through a public–private partnership. During 2019, the U.S. Bureau of Land Management (BLM) worked to complete the Environmental Impact Statement (EIS), releasing the draft EIS in August 2019.

Arctic

At the 43.5-million-ton Arctic VMS deposit, Trilogy Metals Inc. continued to advance engineering and environmental work in support of the ongoing feasibility study and preparation for permitting (photo 9). Site work included additional hydrological and geotechnical work, including a ten-hole, 7,946-foot drill program. Other work in support of the feasibility study included analysis and design of water, tailings, and waste-rock management systems, as well as further metallurgical testing.

Photo 9. Division of Mining, Land and Water staff observe fish-related environmental work at Trilogy Metals' Arctic project, northern Alaska. Photo courtesy of Jenny March, DMLW.

Bornite

At the Bornite carbonate-hosted copper–cobalt deposit (see appendix D for current resource), South32 funded a $9.2 million, 24,967-foot infill and expansion drill program. Three holes tested geophysical anomalies within half a mile of the deposit, while the remaining seven tested extensions of the deeply buried mineralization of the South Reef zone. Highlights include a 154.3-foot South Reef intercept averaging 2.03 percent copper and 0.01 percent cobalt (hole RC19-259).

District-wide exploration

Trilogy and South32 jointly funded a $2 million exploration program for the Ambler volcanogenic massive sulfide (VMS) belt and the Cosmos Hills in 2019. The program included a VTEM (versatile time-domain electromagnetic) geophysical survey. The companies also drilled six holes for a total of 4,452 feet at the Sunshine prospect, eight miles west of the Arctic deposit, validating previously known massive sulfide and discovering a new zone within the prospect area. Drilling highlights from Sunshine include a 31.8-foot interval averaging 3.93 percent copper, 3.0 percent zinc, 0.77 percent lead, 0.0064 ounce of gold per ton, and 2.13 ounces of silver per ton (hole SC19-21). In October, Trilogy staked an additional 465 State mining claims, an increase of 66 percent over the previous State claim block.

Sun

At the Sun VMS property in the eastern Ambler Mining District, owner Valhalla Metals Inc. commissioned a ZTEM airborne electromagnetic and magnetic geophysical survey of the property during 2019. The Sun property includes the 15.2-million-ton Sun deposit (appendix D) and several other prospects and targets.

Western Region

Graphite Creek

The advanced-exploration stage Graphite Creek project, located 34 miles north of Nome, hosts the United States' largest large-flake graphite deposit. Owner Graphite One Inc. continued the evaluation of the project during 2019, initiating work on a pre-feasibility study. In support of this study, the company announced an upgraded mineral resource for the project in March 2019 (appendix D). On-site work continued, including a small program in support of engineering, mine-design, and environmental work (photo 10). Product research and development also progressed, with the company announcing that material from the Graphite Creek deposit was being tested by a major U.S. multinational electric vehicle manufacturer.

Photo 10. Graphite One conducted a three-core hole drilling program in late 2019 in support of a pre-feasibility study at the Graphite Creek property on the Seward Peninsula. Geotechnical and geo-mechanical data for engineering and design of an open-pit mine, associated facilities, and infrastructure were collected. Photo courtesy of Stan Foo, Graphite One Inc.

Illinois Creek

Western Alaska Copper & Gold (WAC&G) continued exploration of the Illinois Creek property, located 55 miles south of Galena in western Alaska. The Illinois Creek property hosts the past-producing Illinois Creek mine, the Round Top copper porphyry prospect, and other prospects. In 2019, the company released a Canadian National Instrument 43-101 (NI 43-101) compliant resource for the Illinois Creek oxide gold deposit. An estimated 296,000 ounces of gold and 10 million ounces of silver (indicated plus inferred; appendix D) remain in the orebody, which was previously mined from 1997 to 2002. The company has initiated a preliminary economic assessment for the project. At Round Top, WAC&G ran a seven-hole, 5,040-foot infill drill program, completing a multi-year effort to ready the prospect for three-dimensional modeling and resource estimation, expected in 2020 (photo 11).

Eastern Interior

Fairbanks District

Fort Knox

Exploration continued to extend the mine life at Kinross Gold Corporation's Fort Knox gold mine 20 miles north of Fairbanks. The company completed 24,000 feet of exploration drilling, mostly focused on the Gilmore area at the western crest of the pit. This work added 229,000 ounces of gold to measured and indicated resources. The company also completed a ground gravity survey from Fort Knox to Gil–Sourdough to help understand the geology of the area for future exploration targeting.

Photo 11. Chalcocite copper mineralization in Round Top drill hole RT-40 in western Alaska. Photo courtesy of Kit Marrs, Western Alaska Copper & Gold.

Amanita

Avidian Gold's Amanita property north of Fairbanks lies approximately four miles southwest of the Fort Knox gold mine. Like Fort Knox, the property is underlain by schist and mid-Cretaceous granite, and northeast-trending faults that run through Fort Knox also transect the Amanita property. In 2019, the company excavated and sampled 5,700 feet of trenches.

Goodpaster District

Pogo

Northern Star Resources Ltd. continued to aggressively pursue new reserves at its Pogo mine 38 miles northeast of Delta Junction. Underground definition and extension drilling focused on the Liese L1, L2, and L3 veins, North Zone, X-Vein, South Pogo, and Fun Zone. Surface-based core drilling continued with four rigs at the Goodpaster Zone located west of the Goodpaster River and about half a mile from current mining areas. Pogo geologists consider this zone of flat-lying and high-angle veins to be the fault-offset continuation of the main Pogo vein system.

In August 2019, Northern Star announced a 43 percent increase in resources (all categories) to 5.95 million ounces of gold at an average grade of 0.28 ounce of gold per ton. Included are maiden resources for the recently discovered Central Veins and the Hill 4021 deposit; each host contains 0.5 million ounces of gold. The company will continue working to convert resources to reserves, which stood at 1.5 million ounces of gold as of mid-2019.

64North Gold Project

In December 2019, Millrock Resources Inc. entered into a joint-venture agreement with Resolution Minerals Ltd. of Australia to explore their large claim block adjacent to Northern Star's Pogo mine. On-site work included acquisition of an 8-line-mile CSAMT (controlled-source audio-frequency magnetotellurics) geophysical survey over the West Pogo block immediately adjacent to Northern Star's recent Goodpaster discovery. As 2019 ended, the partners were preparing for a winter drill program to test targets generated by the geophysical survey.

Tibbs

Tectonic Metals, Inc. continued exploration at their Tibbs gold project 22 miles east of the Pogo mine. Mineralization at Tibbs comprises high-grade, near-surface gold hosted by high-angle quartz–arsenopyrite veins and sheeted to stockwork quartz–sulfide veins. The 2019 program followed up on the previous year's property wide DIGHEM geophysical survey, testing nine targets with fences of RAB (rotary air blast) drill holes across mineralized structures defined in trenching. Results include 0.18 ounce of gold per ton over a drilled intercept of 95 feet at the Michigan prospect (photo 12).

Healy Claims

Northway Resources Corp. conducted its inaugural exploration drilling program at its Healy property, located 29 miles southeast of the Pogo mine in the Goodpaster Mining District. The company drilled 10 reverse-circulation holes as an initial test of the Bronk target, a gold–arsenic–antimony soil anomaly associated with a high-angle structural corridor. Results indicate broad areas of low-grade gold mineralization, including 0.012 ounce of gold per ton over a 162-foot drill intercept in hole HRC19-02.

Photo 12. Surface sample from Tectonic Metals' Michigan prospect (Tibbs property in interior Alaska) of multi-pulsed quartz veining composed of gray to white quartz with up to 15 percent banded fine-grained arsenopyrite and >1 percent pyrite. Last accessed February 18, 2021; NI 43-101 Technical Report at www.tectonicmetals.com/projects/tibbs/#geology.

Photo 13. International Tower Hill Mines Ltd. continued water collection at its Livengood project in interior Alaska as part of environmental baseline studies. Last accessed February 18, 2021; www.ithmines.com/livengood-gold-project/photo-gallery/.

Richardson Subdistrict

Sam

Great American Minerals Exploration, Inc. (GAME) conducted a $7 million, 32,000-foot drill program at its consolidated SAM project in the Richardson mining subdistrict between Fairbanks and Delta Junction. The program focused on upgrading the inferred oxide–gold resource at the Naosi deposit and defining new oxide–gold resources at the Mon Ridge East prospect. As of 2017, Naosi hosted an inferred mineral resource of 1.5 million ounces of gold at an average grade of 0.1 ounce of gold per ton; of this total, an estimated 691,000 ounces are in oxidized rock, with the balance in refractory sulfide-bearing rock.

Tolovana District

Livengood

International Tower Hill Mines Ltd.'s (ITH) Livengood gold project is an advanced-exploration-stage, intrusion-related gold deposit located 75 road miles northwest of Fairbanks. Under the mining scenario presented in their 2017 pre-feasibility study, the deposit has combined reserves and resources totaling 637 million tons at an average grade of 0.020 ounce of gold per ton, a total of 12.6 million ounces of contained gold (appendix D). In 2019, the company spent $3.7 million on continued optimization of deposit metallurgy and engineering, as well as continued environmental baseline studies (photo 13).

Shorty Creek

Freegold Ventures Ltd. partnered with major mining company South32 Ltd. to explore the Shorty Creek intrusion-related, copper–gold–silver–tungsten property approximately 75 road miles northwest of Fairbanks. South32 funded a five-hole, 5,060-foot program at the Hill 1835 and Hill 1710 prospects, as well as 62 line-miles of induced polarization (IP) geophysics and 61 line-miles of ground-based magnetic surveying.

Peak (Tetlin) project

Peak Gold LLC, a joint venture of Contango ORE and Royal Gold Inc., attempted to sell the

Peak and North Peak gold–silver–copper skarn deposits, located 11 miles south of Tok, during the first half of 2019. Peak and North Peak collectively host a resource of 11.6 million tons grading 0.114 ounce of gold per ton, 0.421 ounce of silver per ton, and 0.153 percent copper (appendix D). Unable to secure a buyer, the company redirected their efforts towards exploring targets near the Peak resource and, farther afield, at the Hona intrusion-related gold–silver–copper prospect 16 miles to the west. The company completed IP in the Peak area, and a 625 line-mile helicopter-borne magnetic and VTEM survey over part of the Hona and Eagle prospects. Drills tested East Peak targets with three holes. The company drilled two holes at Hona, intercepting gold–silver–copper mineralization including a 56-foot interval averaging 0.012 ounce of gold per ton, 0.16 ounce of silver per ton, and 0.33 percent copper (hole HN19002).

Seventymile

Tectonic Metals, Inc. continued exploration at its Seventymile gold project, located 40 miles west of Eagle. The project includes the Flanders, Alder Creek, and Bonanza Creek lode prospects, among others, and is leased from underlying landowner Doyon, Ltd. Tectonic geologists are using a high-grade, shear-zone gold exploration model to generate targets on the property. Work in 2019 included target definition using a Geoprobe drill to collect top-of-bedrock samples.

Northway

Tectonic Metals, Inc. continued exploration of the Northway copper–gold project along the Alaska Highway near Northway. The property includes the Road Metal prospect, Target 6, and Target 7, and is leased from underlying landowner Doyon, Ltd. Road Metal is an intrusion-related, silver–gold–base-metal system and may represent the distal expression of a porphyry copper system. Target 6 is a greater-than-4,000-foot-wide copper–molybdenum–gold soil anomaly, and Target 7 is a greater-than-2,500-foot-long gold-in-soil anomaly. Work in 2019 consisted of top-of-bedrock Geoprobe drilling to target future drill tests of targets 6 and 7.

Tanacross

Kenorland Minerals' Tanacross project comprises a cluster of porphyry-type prospects about 55 miles northeast of Tok, including the Taurus, Bluff, East Dennison, Pushbush, and Big Creek prospects. Freeport–McMoRan optioned the property in 2018. Exploration work in 2019 on the project included a property-wide helicopter-borne ZTEM and aeromagnetic survey and nearly 30,000 feet of core drilling on targets in the Taurus–Bluff area (photo 14). In 2010 Senator Minerals reported a non-NI 43-101-compliant, inferred mineral resource estimate for Taurus of 82.7 million tons grading 0.275 percent copper, 0.032 percent molybdenum, and 0.0048 ounce of gold per ton, which was based on ten drill holes with an average spacing of 474 feet.

Oreo

Kennecott Exploration explored the Oreo Mountain copper–molybdenum porphyry prospect under option from Tubutulik Mining Company LLC. The prospect lies 37 miles east of Tok and was known principally as a copper–molybdenum soil anomaly until drill testing in 2019. Kennecott tested three main target areas with a total of six relatively shallow holes, the deepest being 613 feet. Copper ± molybdenum mineralization was intercepted in all six holes, with broad intercepts of low-grade copper mineralization

Photo 14. Kenorland Minerals drilled more than a dozen drill holes on its Tanacross project in interior Alaska in 2019. Photo courtesy of Evan Twelker, DGGS.

in most holes. Several holes intercepted locally strong molybdenum mineralization associated with potassium-feldspar alteration.

Golden Zone

Avidian Gold Alaska Inc.'s Golden Zone property, 25 miles southwest of Cantwell and accessed off the Parks Highway, contains numerous igneous-related mineral occurrences over a 9.3-mile strike length. The property's Golden Zone Breccia Pipe deposit has an NI 43-101-compliant resource of 6.1 million tons grading 0.05 ounce of gold per ton and 0.247 ounce of silver per ton: 303,300 ounces of gold and 1,509,200 ounces of silver (appendix D). The mineralized breccia pipe is located in the core of a Late Cretaceous porphyry stock, and the greater Golden Zone property contains skarn, carbonate replacement, and porphyry mineralization. No drilling was performed at Golden Zone in 2019, but the company conducted a limited program of core relogging, reinterpretation, prospecting, and geochemical sampling.

Alaska Range Project

PolarX's Alaska Range project comprises a collection of copper- and gold-bearing deposits and prospects accessed from the Denali Highway between Paxson and Cantwell. These include the sediment-hosted-copper Caribou Dome deposit (3.1 million tons grading 3.1 percent copper; appendix D); the Zackly gold–copper skarn deposit (3.75 million tons grading 1.2 percent copper, 0.58 ounce of gold per ton, and 0.409 ounce of silver per ton; appendix D), and the Saturn, Jupiter, Mars, and Gemini porphyry copper–gold–molybdenum targets. In 2019 PolarX explored the Saturn target with IP and gravity surveying, followed by a five-hole drill program. Drilling intersected intense argillic alteration under 200–650 feet of glacial till. The company also drilled its first hole at Mars, discovering porphyry copper–gold–molybdenum mineralization assaying 0.22 percent copper, 0.002 ounce per ton gold, and 20 ppm molybdenum over an interval of 335 feet (photo 15).

Red Mountain

White Rock Minerals Ltd. continued exploration of their Red Mountain project in the northern Alaska Range in 2019. The property hosts an array of zinc–lead–copper–silver–gold-bearing VMS deposits and prospects, the best known of which are the Dry Creek deposit (2.6 million tons; appendix D) and the West Tundra Flats deposit

Photo15. PolarX discovered porphyry-style veins containing Cu and Mo in its first drill hole at the Mars prospect at its Alaska Range project. Last accessed February 18, 2021; wcsecure.weblink.com.au/pdf/PXX/02174862.pdf.

(7.4 million tons; appendix D). The company's 12-hole, 14,600-foot 2019 drill program tested 10 separate prospects. One highlight from this drilling was the intersection of 4.6 feet of sulfide mineralization grading 13.9 percent zinc, 4.4 percent lead, 3.36 ounces of silver per ton, 0.02 ounce of gold per ton, and 0.3 percent copper. Company geologists interpret this intercept as a 650-foot down-dip extension of the high-grade Fosters mineralized zone, indicating strong potential for building resource along the zone's 4,000-foot strike length. The company also conducted a 1,900 line-mile SkyTEM airborne electromagnetic survey, ground-based CSAMT and fixed-loop EM surveys, and down-hole geophysical surveys. Greenfields target-generation efforts included property-wide geological and geochemical reconnaissance and stream sediment sampling.

Valdez Creek Lode

The Valdez Creek gold lodes are located in the headwaters of the Valdez Creek placer deposits in the south-central Alaska Range. Historical exploration identified five vertically stacked, gold-bearing zones over a vertical distance of 600 feet with a strike length of over 900 feet. The claims are currently being explored by Valdez Creek Mining LLC, who conducted a program of 3,800 feet of core drilling, 3,000 feet of exploratory trenching, and soil sampling in 2019.

South-Central Region

Johnson Tract

The Johnson Tract gold and base-metal deposit lies 125 miles southwest of Anchorage. In 2019 Constantine Metal Resources Ltd. formed a spin-out company, HighGold Mining Inc., to explore Johnson Tract (JT) and other gold-rich assets in Canada. The property was discovered by Anaconda in 1982 and is leased from underlying landowner, Cook Inlet Region, Inc. (CIRI). Geologically, it comprises gold–silver–zinc–copper–lead mineralization associated with quartz stockworks and hosted in Jurassic volcaniclastic rocks; mineralization is interpreted to have formed in a sub-seafloor setting contemporaneous with the host stratigraphy. There are at least nine other altered and (or) mineralized prospect areas over a 7.5-mile strike length (photo 16). In late 2019, HighGold completed a nine-hole, 7,372-foot validation and expansion drill program focusing on the main JT deposit. Highlights include a JT deposit intercept of 246 feet averaging 0.292 ounce of gold per ton, 0.18 ounce of silver per ton, 0.6 percent copper, 9.4 percent zinc, and 1.1 percent lead (hole JT19-090), along with the discovery of a new Footwall Zone beneath the JT deposit: a vein intercept of 68 feet averaging 0.93 ounce of silver per ton, 2.4 percent copper, and 4.9 percent zinc (hole JT19-089). The company also conducted prospecting, geological mapping, and geochemical sampling on the property, identifying multiple drill targets including a potential fault-offset continuation of the JT deposit.

Icy Cape

Icy Cape is gold- and heavy mineral beach-placer prospect located in the Gulf of Alaska near Icy Bay, about 75 miles northwest of Yakutat. The land is owned by the Alaska Mental Health Trust Authority and managed by the Trust Land Office (TLO). The TLO's Icy Cape Gold and Industrial Heavy Minerals project is a staged, incremental effort to evaluate the potential for producing industrial heavy minerals (garnet, epidote-group minerals, magnetite, ilmenite, zircon, rutile) as part of a placer gold operation. TLO has recently conducted aeromagnetic surveying and exploration drilling to establish the scope of potential resources, and they have performed testing on garnet and epidote concentrates to demonstrate their marketability as abrasive media and water-filtration media. No drilling was conducted in 2019, but TLO did conduct surface sampling on site and continued to analyze the core samples collected during 2018.

Southwestern Region

Donlin

Donlin Gold, a proposed large open-pit gold mine in southwestern Alaska, is a 50/50 partnership between Barrick Gold Corp. and NovaGold Resources Inc. The deposit contains proven and probable reserves of 34 million

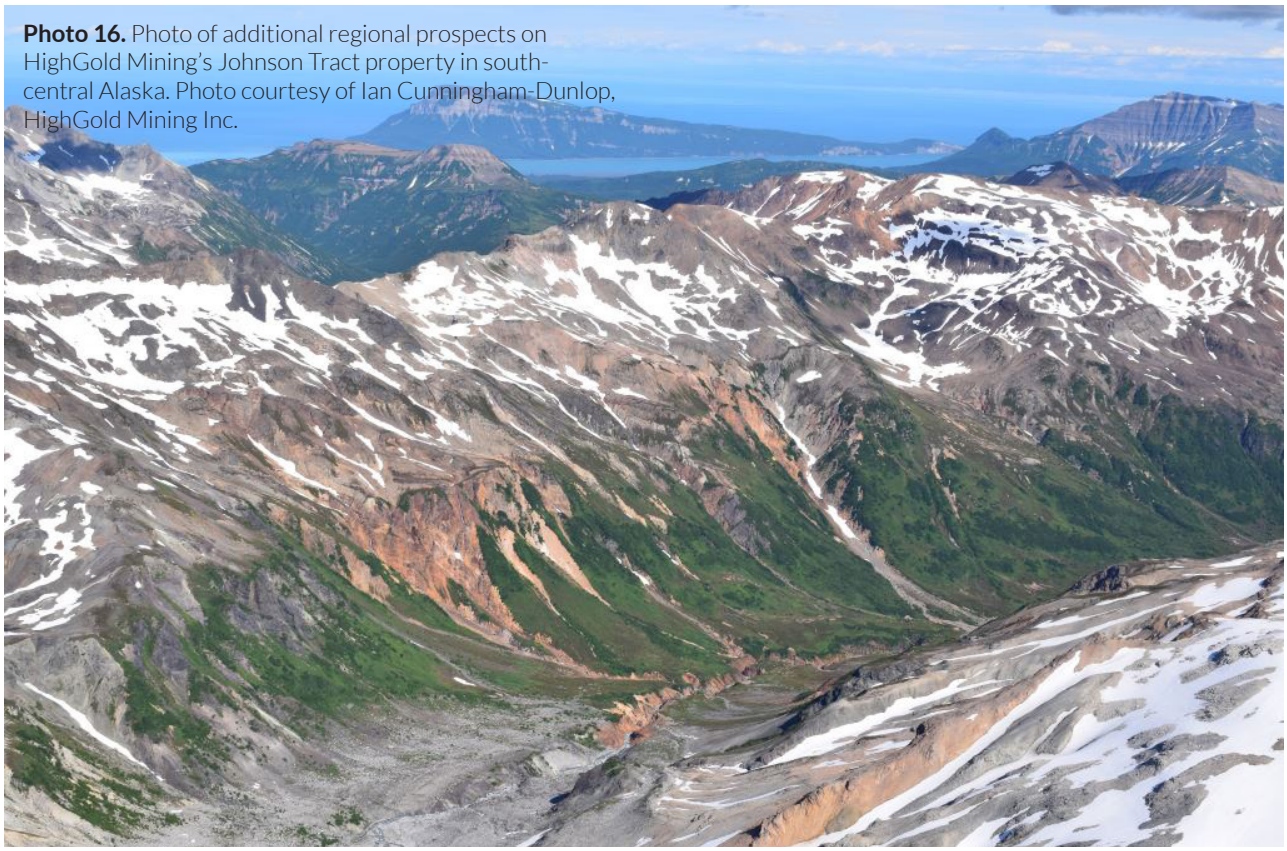


Photo 16. Photo of additional regional prospects on HighGold Mining's Johnson Tract property in south-central Alaska. Photo courtesy of Ian Cunningham-Dunlop, HighGold Mining Inc.

ounces of gold at an average grade of 0.06 ounce of gold per ton (appendix D). The project continued to move through the permitting process in 2019, at year's-end securing permits and easements for the access road, fiber optic cable, and buried natural gas pipeline through Rainy Pass. Several other key Federal and State permits were secured during 2018, including the U.S. Army Corps of Engineers (USACE) and the BLM issued a joint Federal Record of Decision and combined permit under section 404 of the Clean Water Act (photo 17). In mid-2019, the partners commenced a multi-year, on-site geotechnical program to upgrade the engineering of the tailings facility to the detailed level of design required for the project's dam safety permits.

Pebble

The Pebble porphyry copper–gold–molybdenum deposit in southwestern Alaska is one of the world's largest undeveloped mineral resources. The project is being advanced by the Pebble Limited Partnership (PLP), a wholly owned subsidiary of Northern Dynasty Minerals, Ltd. The deposit comprises two zones, the surface-minable Pebble West, and the larger and higher-grade Pebble East, which would require underground block-cave mining. Combined, the deposit has a total mineral resource (all categories) of 82.0 billion pounds of copper, 106.5 million ounces of gold, and 5.6 billion pounds of molybdenum (appendix D), as well as important quantities of the strategic and critical minerals palladium and rhenium.

In December 2017, PLP initiated the Federal and State permitting process for a reduced-scope mining plan that would exploit the Pebble West orebody over a 20-year mine life. This scenario would produce 7.4 billion pounds of copper, 12.1 million ounces of gold, and 398 million pounds of molybdenum from approximately 1.3 billion tons of ore. Cyanide would not be used for secondary gold recovery. The footprint of major mine facilities would be reduced to 5.3 square miles, and no facilities would be built in the Upper Talarik Creek drainage. The company has not completed a current and comprehensive economic analysis for this mine scenario.

Photo 17. The Army Corps of Engineers (USACE) and the BLM issued key permits to Donlin Gold in 2018. Last accessed February 18, 2021; donlingold.com/contact/media-request/.

In February 2019, the U.S. Army Corps of Engineers (USACE) released the Draft Environmental Impact Statement (DEIS) for the project. USACE proceeded to the public-comment phase and the release of the final EIS in 2020. In July 2019, the U.S. Environmental Protection Agency withdrew a Proposed Determination that would have restricted development under Section 404(c) of the Clean Water Act.

PLP spent a total of $53 million on the project in 2019, including $19 million on engineering studies and $14.7 million on environmental studies. Site work included geophysical and geotechnical work in support of engineering and permitting of the project's ferry landing and seafloor natural gas pipeline, as well as geotechnical drilling in support of groundwater modeling at the proposed mine site.

Groundhog

The Groundhog prospect, explored by Quaterra Resources Inc. and Chuchuna Minerals Company, is a copper–gold porphyry exploration project lying 190 miles southwest of Anchorage and 14 miles north of the Pebble deposit. During fall 2019, project operators completed a 1,034 line-mile ZTEM airborne geophysical survey covering 165 square miles of the property. Data processing resulted in eight top-ranked targets, which the companies explored with a limited, late-season geologic reconnaissance program.

Terra

WestMountain Gold Inc. continued exploration of its structurally controlled, high-grade Terra gold vein system in the western Alaska Range. The project hosts an estimated 420,000 ounces of gold at an average grade of 0.446 ounce of gold per ton (appendix D). In 2019 WestMountain Gold completed a 20-hole, 16,800-foot drill program targeting the Ben and Fish zones. The company also conducted a small surface sampling program of soil and rock sampling.

Estelle

Nova Minerals Ltd. continued exploration at the Estelle gold project in the western Alaska Range, approximately 110 miles northwest of Anchorage. The company focused efforts on the Oxide prospect, beginning the season with ground-based magnetometer, IP, and resistivity surveys, then following up with an 18-hole, 4,500-foot reverse-circulation drill program. Intercept highlights from drilling include 230 feet averaging 0.035 ounce of gold per ton (hole OX-RC-16), and 200 feet averaging 0.014 ounce of gold per ton (hole OX-RC-17; photo 18). On the basis of this drilling and three core holes completed by its predecessors, Nova Minerals announced a maiden, JORC-compliant inferred resource for the Oxide–Korbel prospect of 2.5 million ounces of gold (200 million tons averaging 0.013 ounce

Photo 18. Drilling at Nova Minerals' Estelle property in southwestern Alaska in 2019. Last accessed February 18, 2021; novaminerals.com.au/estelle-gold/.

of gold per ton using a 0.0053 ounce of gold per ton cut-off grade; appendix D). In late 2019, the company reported results of initial beneficiation studies indicating 76 percent recovery of gold by cyanide leaching over 12 hours.

Southeastern Region

Greens Creek

At the operating Greens Creek silver–gold–zinc–lead mine southwest of Juneau, exploration by Hecla Mining Company continues to ensure reserves at least ten years ahead of current mining. At year-end 2019, silver, gold, zinc, and lead reserves had increased over 2018 reserves by 22, 11, 10, and 16 percent, respectively. The current proven and probable silver and gold reserves are the highest since 2001. See appendix D for detailed reserves and resources.

The approximately $1 million 2019 exploration program comprised 11,600 feet of underground core drilling targeting the East Ore and 200 South zones. Recent drill intercept highlights include 56.6 ounces of silver per ton, 0.13 ounce of gold per ton, 4.5 percent zinc, and 1.5 percent lead over 4.3 feet from the East Ore Zone, and 16.8 ounces of silver per ton, 0.24 ounce of gold per ton, 12.7 percent zinc, and 6.1 percent lead over 22.4 feet in the 200 South Zone.

Kensington

Coeur Alaska Inc. invested $7.6 million on exploration at its Kensington gold mine 43 miles northwest of Juneau. As a sign that its exploration efforts are bearing fruit, in 2019 Kensington more than doubled its inferred gold resources, including the calculation of a maiden resource for the Elmira vein. Three underground core drills focused on resource expansion drilling at the Eureka, Jualin, Lower Raven, Elmira, Johnson, and lower Kensington Zone 10 (photo 19). The company continued to get consistent and encouraging results from the Eureka vein, with intercept highlights including 6.5 feet of 1.24 ounces of gold per ton (hole EU19-2050-216-X03) and 15.4 feet averaging 0.34 ounce of gold per ton (hole EU19-2050-196-X02). A surface-based drill rig tested the Comet and Seward veins for the first time; intercept highlights from these veins include 2.0 feet assaying 5.55 ounces of gold per ton (hole C19-X001). End-of-year reserves stood at 366,000 ounces of gold, plus 762,000 ounces measured and indicated, and 358,000 ounces of gold inferred.

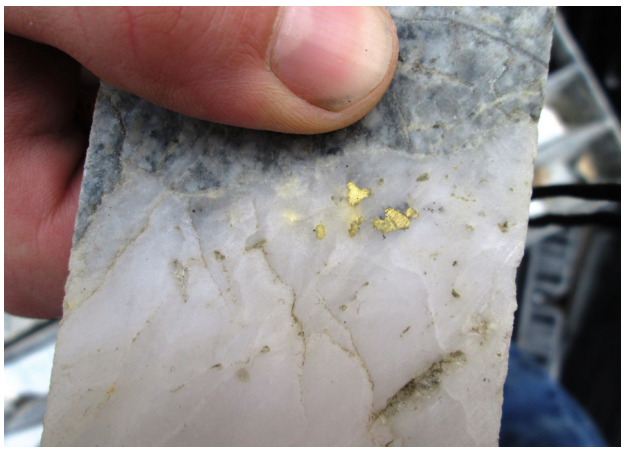


Photo 19. Visible gold in Jualin drill core from the Kensington mine in southeastern Alaska. Photo courtesy of Jan Trigg, Coeur Alaska, Inc.

Palmer project

The Palmer VMS project near Haines is being explored by partners Constantine Metal Resources Ltd. (operator; 51 percent interest) and Dowa Metals & Mining Alaska Ltd. (49 percent interest). Palmer is an advanced-exploration-stage, zinc–copper–silver–gold–barite deposit; it occurs in the same belt of rocks that hosts Greens Creek mine, one of the world's richest VMS deposits. In 2019, the company released a preliminary economic assessment (PEA) of the project under a 3,800 tons-per-day mining and processing scenario. The PEA indicates an 11-year mine life, pre-production capital costs of $278 million, a pre-tax net present value of $354 million (7 percent discount rate), and a post-tax payback period of 3.3 years.

The company completed an eight-hole, 10,384-foot drilling program targeting extensions of the RW West Zone and the AG Zone, as well as a previously untested sub-ice geophysical target (photo 20). Hole CMR19-140, a 1,100-foot step-out from the RW West zone, intercepted

15.1 feet of 0.52 percent copper, 4.65 percent zinc, 0.81 ounce of silver per ton, 0.006 ounce of gold per ton, and 43.7 percent barite. The RW Zone was not included in the 2019 PEA but lies close to planned mining infrastructure.

The future of exploration at Palmer will require underground drilling and bulk sampling. While the company worked on the surface infrastructure leading to the portal site, the Waste Management Permit required for development of the exploration adit remains on-hold pending resolution of *County of Maui, Hawaii v. Hawaii Wildlife Fund* before the U.S. Supreme Court.

Bokan Mountain

Ucore Rare Metals Inc.'s Bokan Mountain property 35 miles southwest of Ketchikan hosts Alaska's only defined resource of rare earth elements (REE); it is particularly rich in the more valuable and strategically important heavy REE (see appendix D for resource details). In addition to definition of the mineral resource, the company completed a 2013 preliminary economic assessment and secured the promise of long-term, low-interest financing through Alaska Industrial Development & Export Authority (AIDEA). In 2019 Ucore remained in litigation with IBC Advanced Technologies Inc. over its right to purchase the "molecular recognition technology" that it previously intended to use for beneficiation of the ore. Pending resolution of this case, the company began to pursue a more conventional solvent extraction (SX) process for extracting and separating the REE from the ore. Work continued on other aspects of the engineering and process design, including the potential to recover co-product elements such as beryllium, zirconium, niobium, and hafnium.

Governmental actions taken during 2019 may also boost the project. In July, the White House issued a series of determinations that begin the process for procurement of REE under the Defense Production Act. In August 2019, Governor Dunleavy nominated Bokan Mountain to the Federal government as a "High Priority Infrastructure Project," a designation that will help to expedite the Federal mine permitting process.

Photo 20. Surface outcropping of AG Zone massive barite at Constantine Metal Resources' Palmer project, southeastern Alaska. Last accessed February 19, 2021; www.constantinemetals.com/site/assets/files/3913/constantine_palmer_pea_report_18july2019_final.pdf.

Herbert Gold

Grande Portage Resources, Ltd. staged a surface exploration program at its Herbert Gold project, an orogenic gold-vein system in the Juneau Gold Belt that also includes the active Kensington mine and the historically productive Alaska-Juneau mine. The 2019 program included trenching and channel sampling of the Deep Trench Vein and Main Vein, as well as additional geologic mapping and sampling of targets generated by the company's 2018 lidar survey. The lidar survey accurately mapped all the known mineralized quartz veins and identified at least 17 additional structures that are similar in geometry and appearance. Grande Portage announced an updated and expanded mineral resource estimate, now totaling 606,500 ounces of gold at an average grade of 0.293 ounce of gold per ton (indicated) plus 251,700 ounces of gold at an average grade of 0.413 ounce of gold per ton (inferred; see appendix D for details).

Snettisham

Resolution Minerals Ltd. (formerly Northern Cobalt Ltd.) staked the previously dormant Snettisham iron–vanadium prospect 32 miles southeast of Juneau in late 2018. The Snettisham prospect comprises locally high concentrations of vanadium- and titanium-enriched magnetite hosted within an Alaska-type mafic-ultramafic intrusion. Vanadium, used in steel alloys and batteries, was designated as a mineral critical to economic and national security by the U.S. government. Northern Cobalt flew a detailed helicopter-borne magnetic survey over the property. Three-dimensional modeling of these data indicates the intrusion could potentially host resources of roughly 1.8 billion tons averaging 20 percent iron, or 470 million tons averaging 40 percent iron. Metallurgical test work completed by a previous company produced a concentrate assaying 66.1 percent iron, 2.85 percent TiO_2, and 0.66 percent V_2O_5 from a composite sample grading 20 percent iron.

Alaska Peninsula Region

Unga project

Redstar Gold Corporation's Unga project includes the historical Apollo-Sitka mine and the Shumagin, Centennial, and Aquila epithermal gold–silver prospects. The Shumagin zone hosts a historical inferred resource of approximately 224,000 ounces of gold and 1,025,000 ounces of silver at grades of 0.8 ounce of gold per ton and 3.65 ounces of silver per ton. In 2019, the company conducted gamma ray geophysics and geochemical sampling as part of an effort to define resource expansion drill targets. Redstar also analyzed satellite imagery from the Zachary Bay area, identifying and mapping zones of clay alteration, silicification, and iron oxides typical of porphyry copper and epithermal systems.

DEVELOPMENT AND PRODUCTION

Alaska's mines reported mostly positive results for production and development in 2019. Development increased by more than four percent to $347.8 million in 2019, continuing a trend of steady year-over-year growth since 2016. Eight projects reported development expenditures; the bulk of development was conducted by Alaska's operating mines (fig. 6). Higher development expenditures in 2019 were attributed to precious-metal-sector budgets, which collectively grew almost 18 percent in 2019 to $184 million (table 8). Expenditures of permitting-stage projects were included in the exploration sector of this report.

Gold became a bright spot in mid-2019, with the year-end price up 18 percent to $1,517, as base-metal prices dropped through most of 2019 (table 9).[7] Variability in commodity prices and Alaska production volumes led to mixed 2019 outcomes for company revenues and estimated production values for commodities. Overall, companies realized four percent more revenue ($2.5 billion; table 1) from commodities in 2019 than in 2018, though the estimated production volumes of gold and zinc slid in 2019 (table 10). For Alaska's mining industry as a whole, revenue losses in 2019 were successfully counterbalanced by increased silver production, higher gold and silver prices, and other internal company strategies. In contrast, the estimated value of mineral production in Alaska for 2019, which includes some theoretical first market values substituted for confidential data, decreased less than 13 percent to $2.8 billion (table 10).

Zinc remains the State's leading mineral product, with an estimated production value of $1.50 billion in 2019 (a 20 percent decrease from 2018; table 10). Zinc accounted for more than half of Alaska's metal production value (fig. 7). The annual value of zinc production has exceeded that of gold since 2014 (appendix B); gold production volumes have trended downward since Alaska's near-record high in 2013. In 2019 silver production grew 17 percent by volume and 22 percent by value, and outpaced lead's production value.

Production & Development

I. Northern Region

1 Red Dog Mine—Teck Alaska Inc.
2. Chandalar placer mine—Goldrich NyacAu Placer LLC

II. Western Region

3. Nixon Fork—Mystery Creek Resources Inc.*

III. Eastern Interior Region

4. Fort Knox Mine—Fairbanks Gold Mining Inc.
5. Pogo—Northern Star Resources Ltd.
6. Usibelli Coal Mine—Usibelli Coal Mine Inc.

IV. South-central Region

V. Southwestern Region

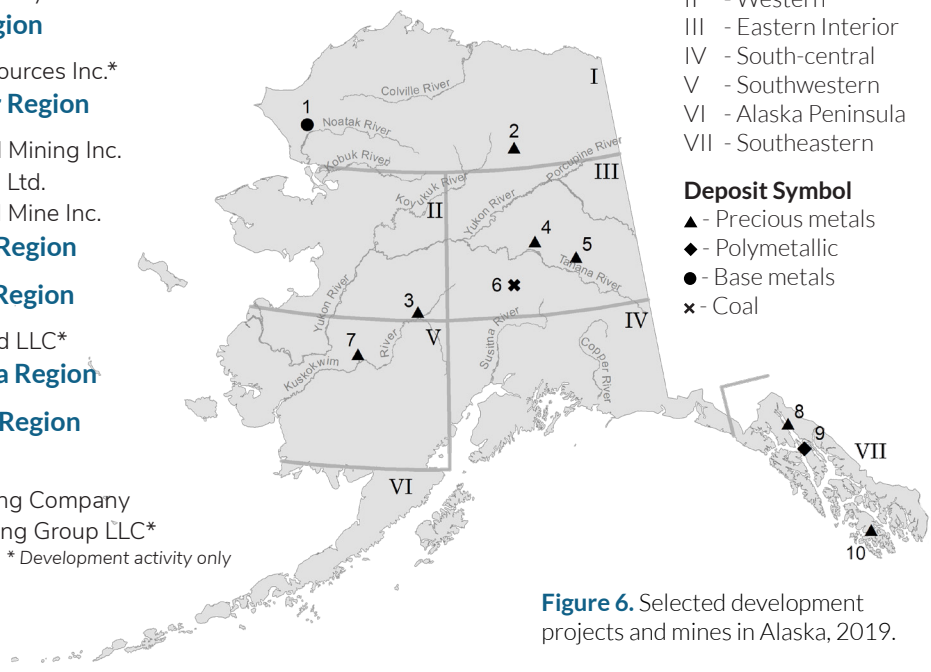
7. Donlin Gold project—Donlin Gold LLC*

VI. Alaska Peninsula Region

VII. Southeastern Region

8. Kensington—Coeur Alaska Inc.
9. Greens Creek Mine—Hecla Mining Company
10. Dawson Mine—Sundance Mining Group LLC*

** Development activity only*



Regions
I - Northern
II - Western
III - Eastern Interior
IV - South-central
V - Southwestern
VI - Alaska Peninsula
VII - Southeastern

Deposit Symbol
▲ - Precious metals
◆ - Polymetallic
● - Base metals
× - Coal

Figure 6. Selected development projects and mines in Alaska, 2019.

Table 8. Reported mineral development expenditures in Alaska by commodity, 1982–2019.

Year	Base Metals	Polymetallics[a]	Precious Metals	Gemstones[b]	Industrial Minerals	Coal and Peat	Total
1982	$ 10,270,000		$ 19,320,000		$ 4,251,000	$ 7,750,000	$ 41,591,000
1983	19,500,000		7,112,500		1,000,000	250,000	27,862,500
1984	10,710,500		15,058,555		579,000	27,000,000	53,348,055
1985	13,000,000		16,890,755		1,830,000	2,400,000	34,120,755
1986[a]	3,260,800	$ 8,000,000	12,417,172		124,000	530,000	24,331,972
1987	38,080,000	48,000,000	13,640,848		188,000	342,000	100,250,848
1988	165,500,000	69,000,000	40,445,400		--	--	274,945,400
1989	118,200,000	411,000	6,465,350		7,000,000	2,196,000	134,272,350
1990	--	4,101,000	7,136,500		30,000	3,079,000	14,346,500
1991	--	8,000,000	14,994,350		262,000	2,318,000	25,574,350
1992	80,000	4,300,000	23,151,300		404,000	1,655,000	29,590,300
1993	--	10,731,136	15,103,000		433,500	1,400,000	27,667,636
1994	10,000,000	5,000,000	27,392,850		5,000	2,545,000	44,942,850
1995	11,200,000	9,590,000	127,165,750		426,000	200,000	148,581,750
1996	60,000,000	60,100,000	273,042,000		495,000	400,000	394,037,000
1997	133,880,000	7,300,000	26,299,000		500,000	410,000	168,389,000
1998	28,000,000	5,600,000	15,602,000		5,355,000	850,000	55,407,000
1999	12,500,000	2,500,000	15,864,000		400,000	2,575,000	33,839,000
2000	100,000,000	16,400,000	24,699,000		611,000	--	141,710,000
2001	43,800,000	3,300,000	32,719,000		300,000	1,040,000	81,159,000
2002	--	5,700,000	26,655,000		250,000	1,450,000	34,055,000
2003	--	--	38,839,332		315,000	--	39,154,332
2004	17,700,000	6,215,000	177,440,081		4,991,434	2,760,000	209,106,515
2005	28,000,000	16,700,000	301,011,469		856,500	1,350,000	347,917,969
2006	31,200,000	26,183,280	420,759,203		1,566,000	15,985,000	495,693,483
2007	41,374,880	30,766,902	239,931,040		1,320,500	5,385,000	318,778,322
2008	45,000,000	24,000,000	319,702,594		205,113	7,260,000	396,167,707
2009[b]	29,000,000	17,500,000	277,020,142	$ 225,250	270,000	6,800,000	330,815,392
2010	42,000,000	16,300,000	225,793,300	200,000	--	9,000,000	293,293,300
2011	48,590,865	41,657,000	170,931,851	250,000	902,480	9,560,000	271,892,196
2012	35,234,500	62,184,000	235,642,406	--	5,290,870	4,021,544	342,373,320
2013	W	57,119,121	258,130,353	295,000	1,831,369	W	358,775,844
2014	W	W	199,909,824	700,000	756,495	--	281,735,787
2015[c]	W	W	188,226,940	--	--	--	309,938,884
2016	W	47,046,279	133,243,900	--	--	W	217,376,728
2017	W	35,254,986	209,082,444	--	--	W	299,502,316
2018	W	46,863,810	156,263,106	--	--	W	334,112,057
2019	W	35,830,809	184,097,276	--	--	W	347,822,085
Total	**$ 1,096,081,545**	**$ 731,654,323**	**$ 4,497,199,591**	**$ 1,670,250**	**$ 42,749,261**	**$ 120,511,544**	**$ 7,084,478,503**

[a]Polymetallics category added in 1986.

[b]Gemstone development category added in 2009.

[c]Significant development expenditures were not reported for precious metals in 2015.

-- = Not reported

W = Figures withheld for confidentiality purposes. Expenditures are incorporated into the State total.

Gold production from lode mines in the Eastern Interior and Southeastern regions totaled 541,079 ounces in 2019, of which two-thirds was produced from the Fort Knox and Pogo gold mines in the Eastern Interior region (fig. 8). Kensington gold and Greens Creek polymetallic mines in southeastern Alaska, the third and fourth largest gold producers, along with the Dawson mine accounted for the remainder of lode gold production. Placer gold production in 2019 is estimated to be 48,001 ounces; almost nine percent of the total gold produced in Alaska (table 11). Employment related to gold production in 2019 is 1,333 full-time-equivalent jobs; more than 38 percent of mining jobs in all sectors (table 2).

The value of Alaska industrial minerals (rock, sand, and gravel) is at least $7.8 million in 2019 (photo 21). This figure is based on reported production from State lands, the BLM, and the U.S. Forest Service; it does not include Mental Health Trust lands or lands managed by the State Pipeline Coordinator's Office (fig. 9; appendix C). The total estimated volume of industrial minerals sold in the State is 2.7 million tons (including data from all three DNR land offices; table 12), of which the Northern region accounted for 77 percent. The 2019 production volume, value, and employment figures should be considered minimum estimates due to reporting shortfalls. These figures do not account for significant production of industrial minerals on private, Native, and other Federal lands.

The 2019 export value was $1.9 billion for ores, concentrates, and other mining products shipped from Alaska, up more than seven percent from 2018 (table 13). Total exports include copper–gold concentrates from the Minto Mine in Yukon Territory, Canada, that were shipped through the AIDEA-owned terminal in Skagway. Usibelli Coal Mine did not export coal outside of Alaska in 2019 (fig. 10). Alaska exported ores, concentrates, and other mining products primarily to Asia, Europe, North America, Australia, and other Oceania countries in 2019, with $418 million (22 percent) in metal ores going to Canada in particular.[9,10]

Table 9. Average metal prices, 1996–2019.

Year	Gold $/oz	Silver $/oz	Copper $/lb	Lead $/lb	Zinc $/lb
1996	387.60	5.19	1.03	0.37	0.49
1997	330.76	4.91	1.03	0.28	0.59
1998	293.88	5.53	0.75	0.24	0.46
1999	278.70	5.20	0.71	0.23	0.49
2000	279.10	4.96	0.82	0.21	0.51
2001	271.04	4.37	0.71	0.22	0.40
2002	310.06	4.61	0.41	0.21	0.35
2003	363.38	4.88	0.81	0.23	0.38
2004	409.72	6.67	1.29	0.40	0.47
2005	444.74	7.32	1.61	0.43	0.63
2006	603.46	11.55	3.02	0.58	1.47
2007	695.39	13.38	3.24	1.17	1.47
2008	871.96	14.99	3.12	0.94	0.84
2009[a]	972.35	14.67	2.35	0.78	0.75
2010[a]	1,224.53	20.19	3.42	0.97	0.98
2011[a]	1,571.52	35.12	3.99	1.09	0.99
2012[a]	1,668.98	31.15	3.61	0.93	0.88
2013[a,b]	1,411.23	23.79	3.32	0.97	0.87
2014[a,b]	1,266.40	19.78	3.11	0.95	0.98
2015[a,b]	1,160.06	15.68	2.50	0.81	0.88
2016[a,b]	1,250.74	17.14	2.21	0.85	0.95
2017[a,b]	1,257.12	17.04	2.80	1.05	1.31
2018[a,b]	1,268.49	15.71	3.00	1.04	1.37
2019[a,b]	1,392.60	16.21	2.72	0.91	1.16

The figures in this table will change as data are reviewed and updated.

[a] 2009–2019 gold and silver prices from Kitco cumulative average London PM fix; 2009–2012 copper, lead, and zinc from British Columbia Ministry of Energy and Mines.

[b] 2013– 2019 copper, lead, and zinc prices from U.S. Geological Survey Mineral Commodity Summaries, based on London Metal Exchange (LME), and LME average daily settlement.

Development and production estimates in this report are compiled from a variety of online sources: annual reports, 10-K reports, and news

[9] USA Trade Online, U.S. Census Bureau, last accessed February 11, 2021. usatrade.census.gov/

[10] USMCA Alaska State Fact Sheet, International Trade Administration, last accessed February 11, 2021. www.trade.gov/sites/default/files/2020-12/Alaska%20USMCA%20State%20Fact%20Sheet_0.pdf

Table 10. Estimated mineral production in Alaska, 2017–2019.[a,b]

	Production Volume			Production value ($)		
Metals	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**
Gold (ounces)	859,631	711,986	589,080	$ 1,064,039,938	$ 888,302,130	$ 802,502,161
Silver (ounces)	16,085,142	15,116,355	17,674,583	245,911,320	210,826,760	258,052,067
Lead (tons)	140,683	127,427	133,424	279,092,676	252,176,360	233,202,741
Zinc (tons)	649,889	698,218	665,889	1,595,551,564	1,851,779,320	1,486,128,992
Subtotal	--			**$3,184,595,498**	**$3,203,084,570**	**$2,779,885,961**
Industrial Minerals						
Sand and gravel (million tons)[c]	3.9	4.0	2.7	$11,633,541	$10,531,812	$7,768,680
Rock (million tons)	--	--	--	--	--	--
Subtotal				**$11,633,541**	**$10,531,812**	**$7,768,680**
Coal and Peat						
Coal (tons)	873,000	1,000,000	1,000,000	$30,555,000	$35,000,000	$35,000,000
Peat (cubic yards)	--	--	--	--	--	--
Subtotal				**$30,555,000**	**$35,000,000**	**$35,000,000**
Total				**$3,226,784,039**	**$3,248,616,382**	**$2,822,654,641**

[a] Production data from DGGS questionnaires, Internet research, interviews with operators, DOT&PF, and municipalities, regional corporations, and Federal land management agencies.

[b] Values for selected metals, coal, and industrial minerals production are based on average prices for each year unless public values were provided by the operator. Total value does not match the Mining Revenue in Table 1 due to the incorporation of confidential data in the statewide total.

[c] Industrial minerals (rock, sand, and gravel) values are combined into the sand and gravel category in 2017–2019.

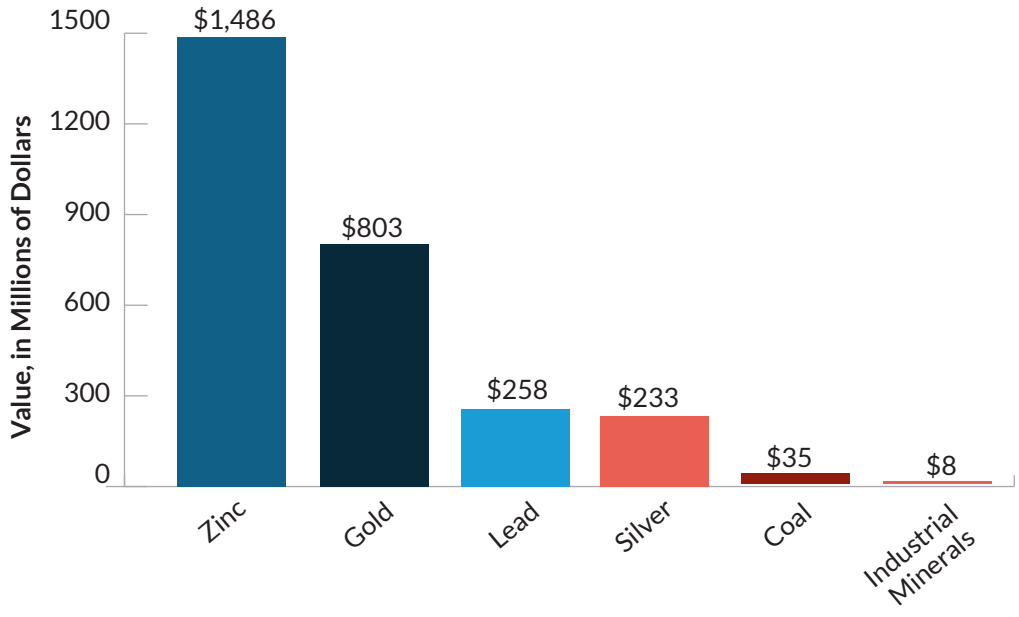


Figure 7. Estimated 2019 mineral production in Alaska by commodity.

Figure 8. Historical gold production in Alaska, 1880–2019, and corresponding market value.

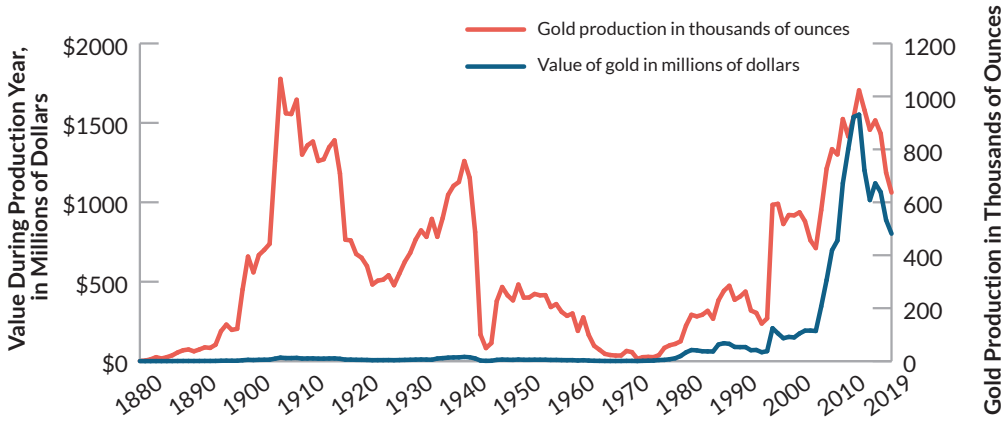


Table 11. Production and employment estimates for Alaska placer gold mines, 2013–2019. Values for 2019 (italics) are estimated based on reported placer data for 2018. Prior-year data are not updated in this table to maintain consistency with calculations and other tables in this report.[a]

	2013	2014	2015	2016	2017	2018	2019 estimate
Number of placer operations reporting gross operating income[a]	229	238	236	205	192	169	169
Total gross operating income reported[a]	$104,994,998	$78,200,155	$64,803,637	$51,912,476	$76,985,791	$66,845,710	$66,845,710
Average yearly price of gold[b]	$1,411.23	$1,266.40	$1,160.06	$1,250.74	$1,257.12	$1,268.49	$1,392.60
Estimated number of gold ounces produced	74,400	61,750	55,862	41,505	61,240	52,697	48,001
Estimated number of full-time-equivalent employees	216	224	222	193	181	159	159

Estimated number of gold ounces produced is calculated by dividing the total gross income by the average price of gold. This yearly estimate does not take into account gold stockpiled, sold in other years, or paid as wages.

Estimated number of employees is calculated by multiplying the number of placer operations by 4 workers per mine, a factor determined for the October 2014 report *The Economic Impacts of Placer Mining in Alaska* prepared by McDowell Group, http://www.alaskaminers.org/economic-benefits. The factor takes into account unpaid family members and workers paid directly in gold. Full-time-equivalent jobs were calculated by multiplying the total number of workers by a ratio of 86 placer miner working-days per year/365 days. The number of placer miner working-days per year was determined by McDowell Group for the October 2014 report.

[a]Values provided by the Department of Revenue. Updated figures for prior years include: in TY 2013, 222 operations reported income of $105,892,074; in TY 2014, 227 operations reported income of $77,560,874; in TY 2015, 220 operations reported income of $63,623,689; in TY 2016, 203 operations reported income of $53,136,679; and in TY 2017, 197 operations reported income of $77,326,581.

[b]2013–2019 gold prices from Kitco cumulative average London PM fix.

releases by companies. They are supplemented by questionnaires returned to DGGS by mining companies, as well as personal communications such as phone calls and emails.

Over the last ten years, the majority of development work has been conducted at mine sites, with development activities being integral to the mining operations. Additionally, there have been few purely development-stage projects. The development sector of the mining process refers to building infrastructure or conducting activities that facilitate production of mineral products. Development expenditures reflect actual expenditures at mines as well as sustaining capital. Sustaining capital includes equipment replacement and rebuilding, facility upgrades, and other expenditures that must be amortized or depreciated in accordance with tax laws; and thus are frequently reported as distinct line items in securities filings. Development activities, whether to build a new mine or make improvements to an existing mine, are often precursors to increased

Photo 21. Marble stockpile at the Calder mine on Prince of Wales Island. Photo courtesy of Mike Lehman, Columbia River Carbonates.

annual production or extended mine life, while production expenditures include those costs directly related to the production of metals.

Average metal prices used in this report are based on the average daily London Metal Exchange (LME) price (table 9). Some respondents reported actual unit values received for production; in cases where actual values were available, they were used in place of the average values. This report uses revenue as reported by producers to quantify production values. If unavailable or confidential, the theoretical first market value (estimated gross value of a pure mineral product at first wholesale) is used instead to approximate the value of production. Therefore, the theoretical first market value does not represent actual sales or gross income of producers; does not take into account shipping, smelting, refining, and other costs incurred by the producer; and may significantly overestimate the actual value of the material.

Red Dog Mine

Red Dog mine in northwestern Alaska is one of the world's largest sediment-hosted massive sulfide zinc deposits. It is operated by Teck Alaska Inc. as an open-pit, truck-and-loader operation that uses conventional drill-and-blast mining methods. On-site mineral-processing facilities employ conventional grinding and sulfide-flotation methods to produce zinc and lead concentrates, which are transported to the coast for shipment during the summer season (photo 22). Teck Alaska leases the road and port facilities from AIDEA.

Red Dog mine consists of three ore bodies: Main (exhausted in early 2012), Aqqaluk (currently active), and Qanaiyaq (active; initial mining in 2017). Reserves and resources for the Aqqaluk and Qanaiyaq deposits as of year-end 2019 are tabulated in appendix D. During the first quarter of 2017, ore from the higher-grade Qanaiyaq deposit was introduced to supplement declining-grade ore from the Aqqaluk pit. Qanaiyaq ore is planned to be about a 20 percent feed source through 2027.

In 2019 Red Dog zinc production decreased to 609,084 tons compared to 642,868 tons in 2018 (table 14), primarily due to fewer tons milled because of planned reduced mill throughput as a result of planned mill shutdowns related to work to increase the installed power of the SAG mill

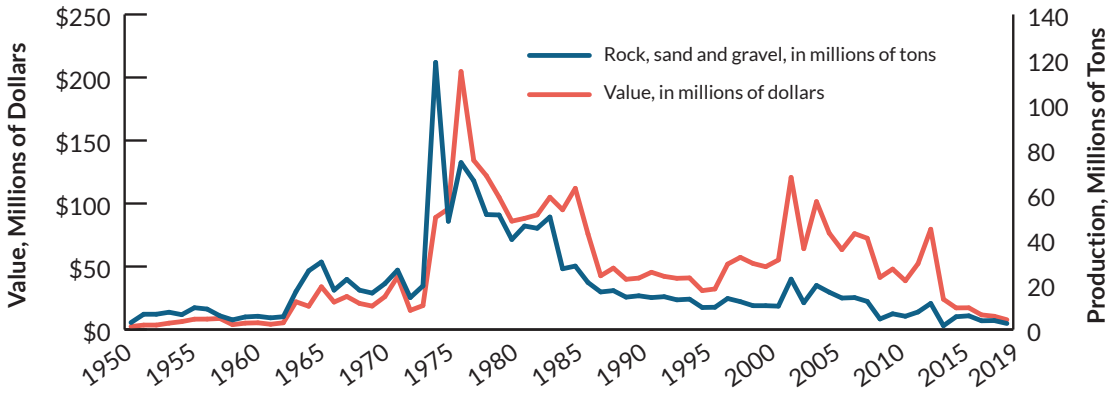


Figure 9. Rock, sand, and gravel production in Alaska, 1950–2019.

Table 12. Material (rock, sand, and gravel) sale volumes (in tons) by region reported on State-owned land, excluding Mental Health Trust lands or lands managed by the State Pipeline Coordinator's Office, for 2011–2019. These volumes do not include material produced from private, Native, or Federal lands, which are significant amounts. These figures serve as minimum amounts of material produced.

Regions	2011	2012	2013	2014	2015	2016	2017	2018	2019
Northern (Fairbanks office)	2,890,304	3,501,387	4,991,349	9,247,223	3,559,580	4,989,855	3,501,847	2,466,002	1,918,082
South-Central (Anchorage office)	70,410	1,035,450	235,050	433,433	2,115,750	396,657	396,657	143,597	529,894
Southeast (Juneau office)	77,940	56,115	69,866	62,559	50,211	13,268	13,268	30,173	32,957
Total Tons	**3,038,654**	**4,592,952**	**5,296,265**	**9,743,214**	**5,725,541**	**5,399,780**	**3,911,772**	**2,639,771**	**2,480,933**

Source: Department of Natural Resources, Division of Mining, Land and Water Southeast Regional Office (SERO), South-Central Regional Office (SCRO), and Northern Regional Office (NRO) Material Sale Tracking Spreadsheets.

DNR material sales volumes and revenues do not correlate, as volumes are attributed to the calendar year in which material was extracted while revenues are tracked on a cash basis (when received), which could be in the subsequent calendar year.

Table 13. Alaska international mineral export values (in millions of dollars).

Year	Mineral Ores and Concentrates[a]	Canada Copper Ores through Skagway Terminal[b]	Precious Metals[c]	Coal[d]	Total Value of Mineral Exports
1996	$ 249	--	> $1	$ 27	**$ 276**
1997	369	--	> $1	26	**395**
1998	317	--	> $1	8	**325**
1999	359	--	> $1	15	**374**
2000	293	--	1	16	**310**
2001	329	--	3	17	**349**
2002	380	--	47	9	**436**
2003	413	--	84	4	**501**
2004	505	--	110	14	**629**
2005	511	--	132	14	**657**
2006	1,094	--	110	10	**1,214**
2007	1,269	$ 16	132	5	**1,406**
2008	691	103	144	23	**858**
2009	853	64	153	33	**1,039**
2010	1,336	37	214	25	**1,575**
2011	1,809	199	267	31	**2,107**
2012	1,502	169	84	32	**1,618**
2013	1,495	150	22	27	**1,543**
2014	1,750	186	11	17	**1,778**
2015	1,467	99	7	5	**1,479**
2016	1,523	146	26	2	**1,551**
2017	1,794	1	13	0	**1,807**
2018	1,773	43	7	0	**1,780**
2019	1,637	33	274	0	**1,911**

Sources: 1996–2013, 2018, and 2019, U.S. Census Bureau, Origin of Movement Series via USA Trade Online https://usatrade.census.gov/; 2014–2017, Alaska Office of International Trade

[a]HS 26 Mineral Ores: Zinc ores and concentrates, lead ores and concentrates, copper ores and concentrates, silver ores, gold ores and concentrates, zirconium ore (only in 2009), and miscellaneous ores.

[b]Value of Canada copper ores moving through Skagway that are included in Mineral Ores and Concentrates

[c]HS 71 Precious Metals: Gold doré, precious stones, and wrought jewelry

[d]HS 27 Coal

Photo 22. Aerial view of Red Dog operations in northern Alaska, including the mill, warehouse, and mechanic shop. Photo courtesy of Laura Orenga de Gaffory, Teck Alaska Inc.

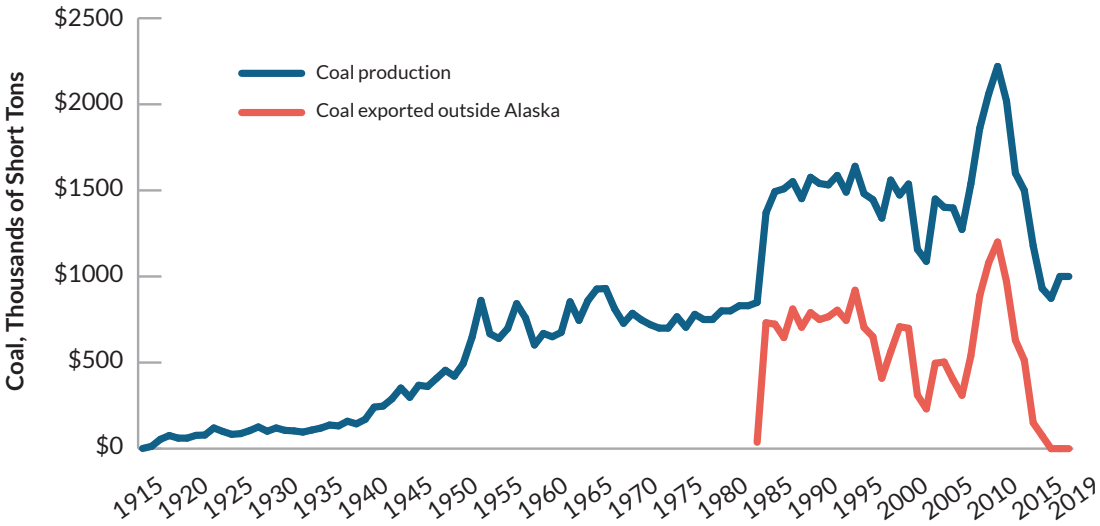


Figure 10. Alaska coal production and exports, 1915–2019.

motors, and lower grades. The zinc grade was 15.4 percent, with an 84.2 percent recovery rate. Lead production in 2019 increased to 113,312 tons, compared to 108,467 tons in 2018, primarily due to higher recoveries. Lead production was lower in 2018 due to the planned major maintenance shut-down of the KIVCET smelter. The lead grade in 2019 was 4.4 percent with a 55.5 percent recovery rate. In 2019 Teck Alaska employed approximately 700 full-time staff (including contractors), mined 11,966,677 tons of material, milled 4,692,680 tons of material, and sold 1.237 billion pounds of zinc and 204.37 million pounds of lead.

Teck's gross profit from Red Dog before depreciation and amortization in 2019 was $631 million, compared with $746 million in 2018. Gross profit in 2019 was $524 million; lower than

Table 14. Red Dog mine production statistics, 1989–2019.[a]

Year	Tons Milled	Ore Grade			Total Tons Concentrate Produced[b]	Contained Tons Zinc	Contained Tons Lead	Million Ounces Silver[c]	Employees[d]
		Zinc (%)	Lead (%)	Silver (oz/ton)					
1989	33,300	20.4	7.6	3.6	8,532	- -	- -	- -	228
1990	996,700	26.5	8.5	3.6	443,600	191,981	31,187	1.6	350
1991	1,599,300	22.5	6.6	2.8	521,400	234,510	43,815	1.46	331
1992	1,582,000	19.9	6.0	2.9	474,900	231,363	15,960	1.38	349
1993	1,874,600	18.4	5.7	2.8	539,800	255,149	24,788	1.51	376
1994	2,339,500	18.8	5.7	2.8	658,000	328,160	32,775	1.84	391
1995	2,485,900	19.0	5.8	2.8	753,600	358,676	55,715	3.62	397
1996	2,312,600	18.7	5.0	2.8	765,300	357,680	65,886	4.3	417
1997	2,127,000	20.3	5.2	2.9	799,400	373,097	69,284	4.27	479
1998	2,752,587	21.4	5.2	2.7	1,015,773	490,461	80,193	5.2	466
1999	3,282,788	21.3	5.2	2.7	1,207,160	574,111	97,756	6.21	539
2000	3,365,508	21.0	4.7	2.5	1,211,539	585,030	91,557	5.84	536
2001	3,560,430	19.8	5.0	2.5	1,215,837	570,980	105,000	5.9	559
2002	3,489,600	21.1	5.4	2.7	1,366,480	637,800	118,880	6.75	560
2003	3,476,689	21.7	6.2	3.1	1,410,892	638,569	137,679	7.7	388
2004	3,249,613	22.0	6.0	3.0	1,337,545	610,900	128,970	7.22	508
2005	3,402,831	21.7	5.6	3.0	1,330,717	626,112	112,766	1.97	449
2006	3,569,280	20.6	6.1	3.0	1,378,384	614,538	136,135	7.62	457
2007	3,726,910	20.2	6.1	3.1	1,428,014	633,511	146,152	11.55	459
2008	3,306,934	20.1	6.0	3.1	1,273,885	567,911	135,143	7.5	475
2009	3,729,119	20.9	5.9	3.1	1,445,870	642,096	144,954	8.12	413
2010	3,937,456	18.2	5.4	3.1	1,300,694	593,043	121,144	6.78	550
2011	4,048,000	19.1	5.0	3.0	1,182,060	572,208	84,033	5.19	586
2012	3,941,000	18.2	4.6	3.0	1,134,415	529,157	95,282	5.89	530
2013	4,243,899	17.0	3.9	NA	1,271,221	607,704	106,594	6.1	550
2014	4,739,302	16.6	4.4	NA	1,409,511	656,971	135,032	7.56	639
2015	4,437,950	14.1	2.9	NA	1,351,221	625,004	129,630	6.7	630
2016	4,684,823	17.1	4.9	NA	1,411,029	642,647	134,813	7.34	600
2017	4,706,864	15.5	5.0	NA	1,322,302	597,342	122,687	7.7	715
2018	4,882,100	15.7	4.4	NA	1,371,264	642,868	108,467	7.0	700
2019	4,692,680	15.4	4.4	3.2	1,320,809	609,084	113,312	7.8	700
Total	**100,577,263**				**33,661,154**	**15,598,663**	**2,925,588**	**169.62**	

[a]Revised slightly from Special Report 51, *Alaska's Mineral Industry 1995*, based on new company data.

[b]Totals for years 1990 through 1995 include bulk concentrate. Total for 2013 estimated from total metal produced for 2013.

[c]Estimate calculated at 56 ounces per ton of lead metal produced from 1990 to 2004 and 2006; as reported credit for 2005, net of treatment charges; calculated at 3.1 ounces per ton of ore for 2007; estimated as proportional with increase in zinc and lead in 2013; as reported in 2014, 2016, 2017, and 2019; calculated based on recoverable silver from reported lead concentrate recovered in 2015; in 2018 calculated from tons milled, the average grades and recoveries stated in the 2017 Red Dog 43-101 report, and the assumption that Aqqaluk and Qanaiyaq contributed 80% and 20%, respectively.

[d]Includes contract employees, if known.

- - = No concentrate produced

NA = Not available

the 2018 value of $651 million, primarily due to lower zinc and lead prices, and higher smelter processing charges as a result of higher benchmark treatment charges. Sustaining capital investments were $55.8 million at Red Dog operations.

Work continued on the $135 million mill upgrade project, which is progressing as planned; $67.1 million of this amount was invested in 2019. Construction started in late 2017, with planned start-up in the first quarter of 2020. The upgrade is expected to increase average mill throughput by about 15 percent over the remaining mine life, helping to offset lower grades and harder ore. Because the upgrade project will permit lower grade material to be processed, the current mine life, which is based on existing developed deposits, will continue to run through 2031.

In 2019 Teck Alaska implemented artificial intelligence to analyze sensor data from the processing plant and to provide automated recommendations to plant operators to maximize efficiency across grinding and flotation, leading to improved throughput and recoveries. This resulted in throughput improvements of approximately 5 percent, which is expected to result in an estimated annual increase in zinc production of approximately 26,455 tons from 2020 onward.

In accordance with the operating agreement between Teck and NANA Regional Corporation, Inc. (NANA) governing the Red Dog mine, Teck pays a royalty on net proceeds of production each quarter. This royalty increases by five percent every fifth year—to a maximum of 50 percent. The most recent increase occurred in October 2017, bringing the royalty to 35 percent. The NANA royalty charge in 2019 was $231 million.

Fort Knox Mine

The Fort Knox plutonic-hosted gold mine, located 20 miles north of Fairbanks, is operated by Fairbanks Gold Mining, Inc., a wholly owned subsidiary of Kinross Gold Corporation (photo 23). The open-pit and truck-and-shovel operation uses carbon-in-pulp, heap leach, and gravity processes to recover gold. Fort Knox production for 2019 totaled 200,263 gold-equivalent ounces. Reduced production compared with 2018 was mainly due to a decrease in mill throughput.

Fort Knox's 2019 production cost of sales was $213.7 million, and $1,067 per equivalent ounce of gold sold. Full-year cost of sales per ounce was higher compared with 2018 mainly due to lower production and higher maintenance costs. In 2019 Kinross employed an average of

Photo 23. Fort Knox pit northeast of Fairbanks. Photo courtesy of Jenny March, DMLW.

Table 15. Fort Knox mine production statistics, 1996–2019.

Year	Tons mined (ore+waste)			Tons Milled (ore)			Tons Placed on Heap Leach[b]	Ounces Gold Produced	Employees
	Fort Knox	True North[a]	Total	Fort Knox	True North[a]	Total			
1996	16,684,000	0	16,684,000	769,700	0	769,700		16,085	243
1997	32,380,000	0	32,380,000	12,163,151	0	12,163,151		366,223	249
1998	33,294,000	0	33,294,000	13,741,610	0	13,741,610		365,320	245
1999	30,350,000	0	30,350,000	13,819,010	0	13,819,010		351,120	253
2000	35,600,000	0	35,600,000	15,000,000	0	15,000,000		362,929	253
2001	25,957,900	8,448,400	34,406,300	13,282,614	2,377,386	15,660,000		411,220	360
2002	24,583,500	11,461,000	36,044,500	11,887,200	3,371,800	15,259,000		410,519	360
2003	30,597,940	12,707,100	43,305,040	11,473,000	3,611,682	15,084,682		391,831	316
2004	44,187,000	3,763,000	47,950,000	12,917,966	1,675,854	14,593,820		338,334	427
2005	63,248,000	0	63,248,000	14,384,842	0	14,384,842		329,320	411
2006	51,070,000	0	51,070,000	14,839,297	0	14,839,297		333,383	406
2007	45,940,000	0	45,940,000	14,021,400	0	14,021,400		338,459	399
2008	46,300,000	0	46,300,000	15,110,000	0	15,110,000		329,105	449
2009	27,585,000	0	27,585,000	17,884,000	0	17,884,000		263,260	500
2010	42,400,000	0	42,400,000	14,560,000	0	14,560,000		349,729	525
2011	34,550,000	0	34,550,000	14,880,000	0	14,880,000		289,794	522
2012	63,120,000	0	63,120,000	14,550,000	0	14,550,000		359,948	565
2013	63,280,000	0	63,280,000	13,960,000	0	13,960,000		428,822	629
2014	49,240,000	0	49,240,000	14,920,000	0	14,920,000	28,500,000	387,285	649
2015	60,860,000	0	60,860,000	14,820,000	0	14,820,000	27,700,000	401,553	657
2016	65,240,000	0	65,240,000	14,570,000	0	14,570,000	32,124,000	409,845	660
2017	60,450,000	0	60,450,000	13,744,703	0	13,744,703	22,340,517	381,115	627
2018	71,850,000	0	71,850,000	12,996,250	0	12,996,250	17,975,390	255,569	630
2019[c]	27,962,298	0	27,962,298	8,905,562	0	8,905,562	20,373,996	200,263	655
Total	**1,046,729,638**	**36,379,500**	**1,055,146,840**	**319,200,305**	**11,036,722**	**321,331,465**	**233,039,907**	**8,071,031**	

[a]True North Mine started production in 2001 and suspended production in 2004.

[b]Walter Creek Heap leach facility started production in 2009, but was not tracked until 2014. Total includes 104.4 million tons placed on heap leach from 2009 through 2013.

[c]Company reported ounces of gold produced in gold-equivalent ounces.

about 655 people, mined 27,962,298 tons of material, processed 8,905,562 tons of ore through the mill, and processed 20,373,996 tons of ore on the heap leach pad at Fort Knox (table 15). Mill grade averaged 0.017 ounce of gold per ton with an 82 percent recovery rate; the heap leach grade averaged 0.007 ounce of gold per ton. Capital expenditures were $141.9 million, and depreciation, depletion, and amortization expenses totaled $91.3 million.

In December 2017, Kinross Gold Corporation gained mineral rights to a 709-acre parcel of land located immediately west of Fort Knox mine. The Gilmore land was conveyed to the State of Alaska by the United States on December 11, 2017. Upon conveyance, the company's existing State mining claims at Gilmore came into effect. As a result, Kinross added 2.1 million ounces of gold in estimated measured and indicated resources and 300,000 ounces of gold in inferred resources at Fort Knox. In 2019 Kinross conducted 24,000 feet of exploration drilling, mainly focusing on the western crest of the pit to expand these resources. This work resulted in the addition of 229,000 ounces of gold in measured and indicated resources. Fort Knox mine reserves and resources as of December 31, 2019 are tabulated in appendix D.

In 2019, the Gilmore development project is proceeding on schedule and on budget. Initial Gilmore ore was mined in the fourth quarter of 2019 and stacked on the existing Walter Creek heap leach pad. Stripping advanced as planned and is expected to continue throughout 2020. Completion of the new Barnes Creek heap leach pad, where 95 percent of Gilmore ore is expected to be stacked, and related pumping and piping infrastructure, remains on target for completion in the fourth quarter of 2020. Mining is expected to continue into 2027, with ore processing running to 2030.

Pogo Mine

The Pogo mine in Interior Alaska consists of a set of structurally controlled, gold-bearing quartz veins that are being mined underground with a cut-and-fill operation and gravity, flotation, and cyanide-leaching processes to recover the gold (photo 24). Northern Star (Pogo) LLC employed 450 full-time staff and more than 200 contractors in 2019. Pogo mine produced 154,589 ounces of gold from 902,373 tons of ore milled, and 875,298 tons of ore and waste materials were moved (table 16). Ore was sourced from the Liese, East Deep, South Pogo, North,

Photo 24. Underground at Pogo mine in interior Alaska. Photo courtesy of Jenny March, DMLW.

Table 16. Pogo mine production statistics, 2006–2019.

Year	Tons Ore Mined	Tons Ore Milled	Ounces of Gold Recovered	Recovery (%)	Head Grade Gold (oz/ton)	Employees[a]
2006	447,129	338,000	113,364	85.0	0.395	477
2007	715,665	715,400	259,820	84.4	0.430	339
2008	882,400	818,237	347,219	83.8	0.506	285
2009	944,823	930,836	389,808	88.2	0.475	272
2010	900,585	947,189	383,434	89.6	0.452	300
2011	892,725	929,020	325,708	89.6	0.392	310
2012	815,922	875,351	315,886	89.7	0.402	335
2013[b]	963,229	875,351	337,393	90.2	0.395	320
2014	972,406	967,230	342,147	89.0	0.396	320
2015	--	--	283,000	--	--	350
2016	1,515,117	941,856	269,342	86.1	0.331	470
2017	1,602,107	974,940	271,273	88.1	0.314	470
2018[c]	1,531,890	880,075	227,901	--	--	540
2019	875,298	902,373	154,589	--	--	650
Total	**13,059,296**	**11,095,858**	**4,020,884**			

[a]Includes contract employees, if known.

[b]Silver production of 32,000 ounces was reported in 2013.

[c] Values are underreported due to the change in ownership to Northern Star Resources in 2018.

-- = Not reported

X Vein, and Fun Zones. Production was lower than in 2018 as Northern Star implemented their mine-changeover plans; the inflection-low point occurred when all low-grade supplementary feed ceased in December 2019.

Northern Star published a 43 percent increase in total resources (as of June 30, 2019) for the Pogo property, including 21,305,448 tons grading 0.280 ounce of gold per ton for 5,949,000 contained ounces of gold, the largest resource in the property's history. This resource includes a maiden resource of 0.5 million ounces of gold at 0.230 ounce of gold per ton for the new Central Veins discovery, and 0.5 million ounces of gold at 0.239 ounce of gold per ton for the Hill 4021 deposit. Pogo mine reserves include 6,727,398 tons grading 0.219 ounce of gold per ton for 1,472,000 contained ounces of gold (appendix D).

Northern Star (Pogo) LLC assumed management control of the Pogo operation in September 2018 and since then has implemented a wide range of operational changes to optimize mining and production.

Northern Star initially focused on creating access to new areas of the mine by increasing the number of headings to enable more efficient use of capital infrastructure in 2019. Key changes included adding a new development fleet, which introduced jumbo bolt and meshing techniques to increase development advances and underground diamond drilling rates. Accelerated in-mine drilling focused on resource conversion and extension proximal to existing infrastructure as well as reserve development. Underground drilling primarily focused on all the major Liese Vein systems (L1, L2, L3), North Zone, X-Vein, South Pogo, and Fun Zone areas, with excellent intersections recorded from all known systems. In August 2019, miners achieved over 4,593 feet of advance per month in production areas, a 76 percent increase from average since implementation of the new development methods. Development-advance rates are targeted at ~4,921 feet per month to enable Pogo mine to reach ~1.43 million tons per year of ore production.

Other adjustments in progress include changing over to a much larger percentage of the new, more cost-effective, long-hole stoping mining method. Long-hole stoping commenced in early 2019, at which time it represented only 11 percent of the processed tons. Northern Star's target for Pogo is for 60 percent of total processing tons to come from stoping, which in turn will

significantly increase gold production and reduce all-in sustaining costs (AISC). Transition to long-hole stoping is on track to reach 60 percent of ore tons in early 2020.

Northern Star's next optimization step was to initiate expansion of Pogo mine's processing infrastructure to de-bottleneck the front end of the plant and increase capacity. In September 2019, Northern Star announced they will invest $30 million in an expansion of the processing plant, which is expected to increase the throughput capacity from 1.10 million tons to 1.43 million tons per year. Work on the expansion started in late 2019 and is expected to be completed in early 2021; it is expected to deliver a ~25 percent cost reduction per ton.

Surface development drilling in 2019 focused on infill and extension drilling of the Central Vein system located immediately northwest of the North Zone and Liese Vein systems. The deposit contains an array of at least six stacked coherent mineralized quartz veins with a current resource of 509,000 ounces of gold. Conceptual development to define and access the Central Veins has been designed and permitting has been established to allow development of initial underground access into the Central Veins.

Usibelli Mine

Usibelli Coal Mine Inc. is a local, family-owned coal mining company in production since 1943 with about 100 full-time-equivalent employees in 2019. The company mines coal from the Miocene Suntrana Formation from leases on State-owned lands in the Healy area. Usibelli's main leases are in the Hoseanna Creek and Jumbo Dome areas. There are four active and past coal resources: Two Bull Ridge, Gold Run Pass, Jumbo Dome, and Poker Flats. The company is currently mining Two Bull Ridge, which has more than ten million tons of coal slated for mining. The Two Bull Ridge resource has 3.5–5 cubic yards of overburden for each ton of coal, which is contained in multiple seams. Number 3 seam averages 18 feet thick, Number 4 seam is up to 32 feet thick, and Number 6 seam averages 21 feet thick. Gold Run Pass is nearing completion of its mining life, with four of five reclamation stages complete. The Jumbo Dome mine region contains approximately 250 million tons of coal, of which about 80 million tons have been permitted. Number 4 seam averages 40 feet thick with 25–75 feet of overburden above it, and Number 3 seam averages 30 feet thick with 35 feet of overburden between it and Number 4 seam. Stripping ratios are 0.5 cubic yards of overburden per one ton of coal. Poker Flats, now fully reclaimed, produced about 27 million tons of coal beginning in the 1970s. All coal is subbituminous, low-ash, and very low in sulfur content.

In 2019 Usibelli produced coal from its Jumbo Dome mine site near Healy and from the Badlands area, for a total output of about 1,000,000 tons. The majority of Usibelli's coal is used for in-state electrical power generation at interior Alaska coal-fired power plants. The University of Alaska Fairbanks recently commissioned a new boiler and 17-megawatt turbine generator (photo 25); Eielson Air Force Base is replacing multiple boilers. Golden Valley Electric Association achieved first commercial production in November 2018 for their Healy Number 2 power plant, a 50-megawatt coal-fired electrical plant at the mouth of the Usibelli mine. At full capacity it is projected to use about 200,000 tons of coal per year; the capacity factor was approximately 54 percent in 2019.

Photo 25. Train cars with Usibelli mine coal at the University of Alaska Fairbanks power plant. Photo courtesy of Jennifer Athey, DGGS.

Kensington Mine

Kensington mine is 45 miles north–northwest of Juneau, and is 100 percent owned by Coeur Alaska, Inc., a wholly-owned subsidiary of Coeur Mining, Inc. It falls within the Berners Bay Mining District at the northern-most edge of the Juneau Gold Belt. The underground Kensington mine consists of at least three major, structurally controlled, orogenic-gold vein systems (Kensington Main, Jualin, and Raven), which are being mined by long-hole stoping and drift-and-fill methods, with gold recovered using flotation processes (photo 26). Kensington mine reserves totaled 366,000 ounces of gold as of December 31, 2019, and additional resources are tabulated in appendix D.

Coeur Alaska, Inc. employed 383 full-time employees in 2019. The mill processed 658,378 tons of material at an average grade of 0.21 ounce of gold per ton with an average 91.0 percent recovery rate (table 17). Full-year production was 127,914 ounces of gold, which was 12 percent higher than in 2018. Coeur sold 130,495 ounces of gold for metal sales of $181.1 million. Costs applicable to sales were $119.6 million, adjusted average cash costs applicable to sales for the year were $910 per ounce of gold, and total sustaining and development capital expenditures were $23.5 million.

Production from the Jualin ore body accounted for approximately 14 percent of Kensington's production. In 2019 Coeur Alaska's Kensington mine produced its one-millionth ounce since full production began in July 2010. Full-year exploration investment for 2019 was $7.6 million, with two underground core drill rigs focusing on resource expansion drilling at the Eureka and Jualin veins, as well as lower Kensington Zone 10 during the fourth quarter. Results were encouraging, particularly at Eureka.

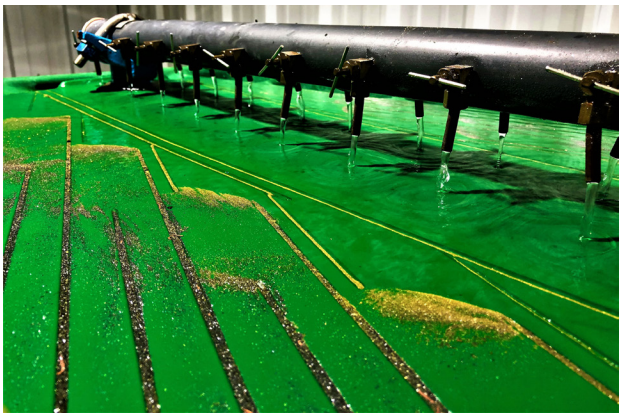


Photo 26. Gold concentrate at Kensington mine in southeastern Alaska. Photo courtesy of Jan Trigg, Coeur Alaska, Inc.

Coeur Alaska is moving forward with Plan of Operations Amendment 1 (POA 1), which is anticipated to extend Kensington's mine life by ten years, with active mining at full production and employment lasting until 2033. The Draft Supplement Environmental Impact Statement (DSEIS) is expected to be available at the end of October 2020, and the U.S. Forest Service should

Table 17. Kensington mine production statistics, 2010–2019.

Year	Ore (tons milled)	Ore Grade Gold (oz/ton)	Gold Recovery (%)	Gold Produced (oz)
2010[a]	174,028	0.28	89.9	43,143
2011	415,340	0.23	92.7	88,420
2012	394,780	0.22	95.6	82,125
2013	553,717	0.21	96.6	114,821
2014	635,960	0.20	94.1	117,823
2015	659,786	0.20	94.9	128,865
2016	620,209	0.21	94.7	124,331
2017	668,727	0.18	93.5	115,094
2018	641,058	0.18	92.3	113,778
2019	658,378	0.21	91.0	127,914
Total	**5,421,983**			**1,056,314**

[a]Production started July 3, 2010.

hold public hearings mid-November 2020 with the DSEIS comment period ending mid-December 2020. Coeur Alaska anticipates receiving the Final SEIS and Record of Decision by the end of July 2021.

Greens Creek Mine

Greens Creek mine is a polymetallic VMS deposit located about 20 miles southwest of Juneau. Greens Creek is 100 percent owned by various subsidiaries of Hecla Mining Company. The underground mine is accessed by a ramp from surface, and is primarily mined by cut-and-fill and long-hole stoping. The ore-processing facility includes a SAG/ball mill grinding circuit, a gravity circuit to recover free gold that exists as electrum, and a floatation circuit that produces three types of concentrates. The 846,076 tons processed at the mill in 2019 contained 12.4 million ounces of silver, 81,223 ounces of gold, 62,863 tons of zinc, and 24,704 tons of lead. Silver, gold, and base-metal production was replaced, and silver, gold, zinc, and lead reserves increased by 22, 11, 10, and 16 percent, respectively, over 2018 reserves.

In 2019 Hecla produced 9,890,125 ounces of silver; an increase of 24 percent compared to 2018 (table 18). Gold production in 2019 was 56,625 ounces; an increase of 10 percent from 2018. The increase in silver and gold production for the year resulted from higher grades. The mine also yielded 20,112 tons of lead and 56,805 tons of zinc. The mill operated at an average of 2,351 tons per day for the year, for a total of 846,076 tons of ore processed. Mining and milling costs per ton were $80.57 and $37.02, respectively. Ore grades milled were 14.64 ounces of silver per ton, 0.10 ounce of gold per ton, 2.92 percent lead, and 7.43 percent zinc. The cost of sales and other direct production costs and depreciation, depletion, and amortization for 2019 was $211,719,000; an increase of 11 percent over that of 2018. The total cash cost, after byproduct credits, was $1.97 per ounce of silver; an increase of $3.10 over 2018. The higher cost of sales and per silver ounce cash costs for the period were primarily due to higher production costs and treatment charges. The all-in sustaining capital (AISC), after byproduct credits, was $5.99 per ounce of silver, an increase of $0.41 over 2018. For the full year of 2019, Greens Creek generated cash provided by operating activities of approximately $136.2 million and spent $35,829,000 on capital additions to properties, plants, and equipment, resulting in free cash flow of $106,881,000. Hecla had 426 full-time employees at Greens Creek in 2019.

Definition drilling at Greens Creek in 2019 focused on upgrading mineralized material to resources and reserves at the East Ore, 9A, NWW, Southwest, and 200 South zones. Greens Creek mine's current proven and probable silver and gold reserves are the highest total reserve since 2001, and reserves and resources as of December 31, 2019 are tabulated in appendix D. The current mine plan accesses higher-grade ore in the earlier years of the mine plan from existing workings, which reduces the required development investment. The mine life from current reserves is expected to be to 2031.

Donlin Gold Project

Donlin is a proposed, large open-pit gold mine located in southwestern Alaska. Donlin is owned by Donlin Gold, LLC, a 50/50 partnership between Barrick Gold Corp. and NovaGold Resources Inc. With key Federal and State permits already in hand, in 2019 Donlin Gold secured final land leases, land-use permits, and material-site authorizations for proposed transportation facilities on State lands, and final easements for the proposed access road and fiber optic cable. In mid-2019, Donlin Gold commenced a multi-year site investigation program to collect additional geotechnical information to advance engineering work on the tailings facility and other water-retention and diversion structures from a feasibility level to a final construction package, as required for the project's dam safety certification application. The total advanced-stage exploration and development budget for the Donlin Gold project for 2019 was

Table 18. Greens Creek mine production statistics, 1989–2019.

Year	Tons Milled	Tons Concentrate	Metal Produced					Employees
			Tons Zinc	Tons Lead	Tons Copper[a]	Ounces Gold	Ounces Silver	
1989	264,600	--	187,007	9,585	--	23,530	5,166,591	235
1990	382,574	--	37,000	16,728	--	38,103	7,636,501	265
1991	380,000	--	41,850	16,900	--	37,000	7,600,000	238
1992	365,000	113,827	40,500	16,500	--	32,400	7,100,000	217
1993[b]	77,780	--	9,500	3,515	--	7,350	1,721,878	217
1994[c]	--	--	--	--	--	--	--	--
1995[c]	--	--	--	--	--	--	--	--
1996[b]	135,000	43,000	9,100	4,200	193	7,480	2,476,000	265
1997	493,000	--	46,000	19,000	1,300	56,000	9,700,000	275
1998	540,000	--	58,900	22,700	1,300	60,572	9,500,000	275
1999	578,358	--	68,527	25,503	1,400	80,060	10,261,835	275
2000	619,438	--	84,082	31,677	1,400	128,709	12,424,093	275
2001	658,000	--	63,903	22,385	1,400	87,583	10,900,000	275
2002	733,507	217,200	80,306	27,582	1,600	102,694	10,913,183	262
2003	781,200	--	76,200	24,800	--	99,000	11,707,000	295
2004	805,789	--	69,115	21,826	--	86,000	9,707,000	265
2005	717,600	--	58,350	18,600	--	72,800	9,700,000	265[d]
2006	732,176	--	59,429	20,992	--	62,935	8,865,818	245[e]
2007	732,227	--	62,603	21,029	--	68,006	8,646,825	276[f]
2008	734,910	--	58,224	18,562	--	67,269	7,145,711	336[g]
2009	790,871	--	70,379	22,253	--	67,278	7,459,170	321[h]
2010	800,397	--	74,496	25,336	--	68,838	7,206,973	343[i]
2011	772,069	--	66,050	21,055	--	56,818	6,498,337	364[j]
2012	789,569	--	64,249	21,074	--	55,496	6,394,235	386[k]
2013	805,322	--	57,614	20,114	--	57,457	7,448,347	390[l]
2014	816,213	--	59,810	20,151	--	58,810	7,826,341	415
2015	814,398	--	61,934	21,617	--	60,566	8,452,153	418
2016	815,639	--	57,729	20,596	--	53,912	9,253,543	414
2017	839,589	--	52,547	17,996	--	50,854	8,351,882	423
2018	845,398	--	55,350	18,960	--	51,493	7,953,003	426
2019	846,076	--	56,805	20,112	--	56,625	9,890,125	426
Total	**18,666,700**	**--**	**1,787,559**	**571,348**	**8,593**	**1,755,638**	**237,906,544**	

[a]No copper credits in 1989–1993 and 2003–2019.

[b]Partial-year production.

[c]No production in 1994 and 1995 due to mine closure.

[d]Fifteen of these employees were assigned to development effort.

[e]Fifty employees were assigned to development and reported in that section's employment.

[f]Forty-five employees were assigned to development and reported in that section's employment.

[g]Nineteen employees were assigned to development and reported in that section's employment.

[h]Eighty-five employees were assigned to development and reported in that sector's employment.

[i]Seventy-nine employees were assigned to development and reported in that sector's employment.

[j]Nineteen employees were assigned to development and reported in that sector's employment.

[k]Thirty-nine employees were assigned to development and reported in that sector's employment.

[l]All employees were assigned to the production sector.

-- = Not reported

$22 million, which was included as exploration funds for 2019. See page "Donlin" on page 29 for additional information on this project.

Nixon Fork Mine

The Nixon Fork underground mine is a copper–gold skarn deposit located 32 miles northeast of McGrath and operated by Mystery Creek Resources, Inc., a wholly owned subsidiary of Titan Resources, Ltd. The Nixon Fork mine is an underground cut-and-fill, shrinkage, and sub-level open stoping operation using gravity and flotation processes to recover copper concentrate, and carbon-in-leach to recover gold. The last reported resources are approximately 145,000 tons, containing 136,000 ounces of gold. In 2019 Mystery Creek continued work to restart the mine.

Dawson Mine

The Dawson mine is located on Prince of Wales Island in southeastern Alaska, about 3.5 miles from the Hollis ferry terminal. It is operated by Sundance Mining Group LLC. The Dawson mine exploits a medium-sized, low-sulfide, high-grade, free-milling gold–silver deposit. Veins are hosted by shale and siltstone of the Descon Formation, which locally contains sills and dikes. The quartz-vein system dips 28 degrees, and ore minerals include galena, chalcopyrite, sphalerite, tellurides, and free gold. Ore occurs within a linear north-trending zone, which from south to north includes the historical Harris River mine, Dawson mine, Upper Crackerjack workings, and Puyallup mine. Mill site development was completed in 2018, and a 150-ton-per-day gravity mill was installed (photo 27). In 2019, the Dawson mine went into production.

Calder Mine

Calder mine is located on the northern end of Prince of Wales Island, 88 miles west of Ketchikan. It was developed as a dimensional marble quarry in the early 20th century, but although the marble is bright white, it didn't meet specifications for monuments or architecture, and the quarry closed after several years of operation. Toward the end of the century, the quarry was restarted by Sealaska Corporation to supply calcium carbonate to various industries. In 2011 Columbia River Carbonates (CRC) purchased the property and began development and renovation of existing infrastructure. Currently, Calder mine has a proven ore reserve that is expected to last at least 75 years, with resource-expansion potential. The ore body is classified as being uniquely pure and yields uniform, bright white

Photo 27. Dawson mine's gravity gold and silver recovery mill, located on Prince of Wales Island. Photo courtesy of Robert Fithian, Sundance Mining Group LLC.

stone. All blasts are designed and planned in a manner that will not contaminate ore and minimize undersized material.

In 2019 CRC produced 330,000 tons of crushed marble from Calder mine, and employed 12 people during the mine's six-month operating season. Mining and barge loading are performed by a local contractor, with an average of two barges per month loaded year-round from stockpiled stone (photo 28). Barges carry the stone to CRC's plant in Woodland, Washington, where it is turned into a range of wet and dry calcium carbonate products for use in the paper, glass, plastics, paint, construction, agriculture, and other industries.

Photo 28. Shiploader at the Calder mine, Prince of Wales Island. Photo courtesy of Mike Lehman, Columbia River Carbonates.

DRILLING

Twenty-three companies publicly reported significant drilling programs in Alaska in 2019 across all sectors; statewide totals include both publicly reported and confidential drilling footages (table 19). Total 2019 drilling decreased to 848,200 feet, down more than 18 percent from 2018 (table 20). Development drilling totaled 273,311 feet, and production drilling totaled 158,244 feet. Twenty-eight individual metal exploration projects reported 416,645 feet in 2019, three more projects than in 2018; however, total footage drilled in 2019 decreased 28 percent. About 183,447 feet of exploration drilling (44 percent) was conducted at mine sites to increase reserves and extend mine life, down 13 percentage points from 2018. Globally, the number of exploration projects with drilling programs and the number of drill holes declined 13 percent and 21 percent, respectively.[7]

Drilling footage was primarily compiled from questionnaires, public company reports, and online information, and represents a minimum amount for 2019. Production drilling is likely under-reported, and placer exploration drilling in 2019 was not compiled. Blast-hole drilling during production at Alaska's large lode mines was not tracked.

Table 19. Companies publicly reporting significant drilling programs in Alaska in 2019.

Ambler Metals LLC	Nova Minerals Ltd.
Coeur Alaska Inc.	Peak Gold LLC
Constantine Metal Resources Ltd.	Piek Exploration LLC
Freegold Ventures Ltd.	PolarX Ltd.
Graphite One Inc.	Teck Alaska Inc.
Great American Minerals Exploration Inc.	Tectonic Metals Inc.
Hecla Mining Company	Tubutulik Mining Company LLC
HighGold Mining Inc.	Valdez Creek Mining Company LLC
Kenorland Minerals	WestMountain Gold Inc.
Kinross Gold Corp.	Western Alaska Copper & Gold
Northern Star Resources Ltd.	White Rock Minerals Ltd.
Northway Resources Corp.	

Table 20. Drilling footage reported or estimated in Alaska, 1982–2019.

Year	Placer Exploration	Placer Thawing	Total Placer	Total Coal	Hardrock Core[a]	Hardrock Rotary[a]	Total Hardrock	Total Feet Drilled
1982	30,000	94,000	124,000	80,000	--	--	200,000	404,000
1983	23,000	30,000	53,000	12,000	--	--	180,500	245,500
1984	31,000	98,000	129,000	25,700	--	--	176,000	330,700
1985	46,000	34,000	80,000	8,700	--	--	131,700	220,400
1986	32,400	227,000	259,400	28,800	--	--	50,200	338,400
1987	50,250	130,000	180,250	19,900	95,600	19,500	115,100	315,250
1988	152,000	300,000	452,000	26,150	223,630	130,230	353,860	832,010
1989	97,250	210,000	307,250	38,670	242,440	89,790	332,230	678,150
1990	78,930	105,000	183,930	18,195	648,600	112,355	760,955	963,080
1991	51,247	130,000	181,247	16,894	205,805	110,850	316,655	514,796
1992	6,740	65,000	71,740	12,875	211,812	148,022	359,834	444,449
1993	25,216	--	25,216	--	124,325	127,990	252,315	277,531
1994	21,000	--	21,000	8,168	347,018	91,692	438,710	467,878
1995	27,570	--	27,570	--	363,690	51,795	415,485	443,055
1996	61,780	--	61,780	8,500	524,330	134,527	658,857	729,137
1997	38,980	--	38,980	13,998	523,676	180,834	704,510	757,488
1998	33,250	--	33,250	2,300	505,408	45,670	551,078	586,628
1999	6,727	--	6,727	--	369,863	78,934	448,797	455,524
2000	15,480	--	15,480	--	418,630	127,638	546,268	561,748
2001	1,100	--	1,100	36,151	240,318	75,750	316,068	353,319
2002	1,250	--	1,250	--	385,290	103,612	488,902	490,152
2003	10,108	--	10,108	2,000	270,456	100,178	370,634	382,742
2004	107,526	--	107,526	--	415,628	36,024	451,652	559,178
2005	3,360	--	3,360	--	592,497	41,780	634,277	637,637
2006	8,759	--	8,759	7,500	765,363	54,173	819,536	835,795
2007	19,575	--	19,575	50,539	830,478	268,112	1,098,590	1,168,704
2008	1,216	--	1,216	26,869	874,634	250,278	1,124,912	1,152,997
2009	1,244	--	1,244	W	403,275	260,059	663,334	664,578
2010	10,427	--	10,427	11,601	688,911	216,768	905,679	927,707
2011	3,150	--	3,150	W	883,272	175,181	1,058,453	1,061,603
2012	13,282	--	13,282	7,704	1,082,439	14,182	1,096,621	1,117,607
2013	17,986	--	17,986	W	933,194	17,800	950,994	968,980
2014	7,227	--	7,227	W	487,106	9,736	496,842	504,069
2015	--	--	--	W	923,324	12,795	937,769	937,769
2016	--	--	--	--	644,512	W	644,512	644,512
2017	--	--	--	W	1,016,731	W	1,016,731	1,016,731
2018	--	--	--	W	1,039,089	W	1,039,089	1,039,089
2019	--	--	--	W	812,933	35,267	848,200	848,200

[a]Core and rotary drilling not differentiated prior to 1987.

W = withheld for confidentiality; included in hardrock rotary or core.

-- = Not reported

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APPENDIX A
Resources Related to the Minerals Industry in Alaska

DEPARTMENT OF NATURAL RESOURCES

Recording Fees – dnr.alaska.gov/ssd/recoff/fees
Public Information Center – dnr.alaska.gov/commis/pic/
State Uniform Commercial Code (UCC) Documents Search – dnr.alaska.gov/ssd/recoff/ucc

Division of Mining, Land & Water

Mining Applications and Forms – dnr.alaska.gov/mlw/forms/
Fact Sheets – dnr.alaska.gov/mlw/factsheets/
Annual Placer Mining Application (APMA) – dnr.alaska.gov/mlw/mining/placer.cfm
Annual Rental – https://dnr.alaska.gov/mlw/cdn/pdf/factsheets/annual-rent.pdf
Leasing State Land – dnr.alaska.gov/mlw/cdn/pdf/factsheets/leasing-state-land.pdf
Land Lease & Contract Payment Information – dnr.alaska.gov/mlw/cdn/pdf/factsheets/land-lease-and-contract-payment-information.pdf
Production Royalty – dnr.alaska.gov/mlw/cdn/pdf/factsheets/production-royalty.pdf
DNR Production Royalty Form – dnr.alaska.gov/mlw/cdn/pdf/forms/Production-Royalty-Form-2020-v2.pdf
Exploration Incentive Credit Program – dnr.alaska.gov/mlw/cdn/pdf/factsheets/exploration-incentive-credit-program.pdf

Division of Geological & Geophysical Surveys

Publications On-Line – dggs.alaska.gov/pubs/
Interactive Maps – maps.dggs.alaska.gov
Geologic Maps of Alaska: Online Map Search Tool – maps.dggs.alaska.gov/mapindex/
Unpublished Geology-Related Data (Alaska Geologic Data Index) – maps.dggs.alaska.gov/agdi/
Geologic Materials Center – dggs.alaska.gov/gmc/
Alaska Geochemistry Web Map – maps.dggs.alaska.gov/geochem/
Alaska Geospatial Council – agc.dnr.alaska.gov/

Alaska's Minerals Data & Information Rescue in Alaska (MDIRA) Project Websites

MDIRA Portal Home Page – akgeology.info
Alaska Mining Claims Mapper – mapper.dnr.alaska.gov
Land Records Web Application – dnr.alaska.gov/landrecords
State Recorder's Office Search – dnr.alaska.gov/ssd/recoff/search
Alaska Resource Data File – ardf.wr.usgs.gov
USGS Alaska Geochemical Database, Version 3.0 (NURE, RASS, PLUTO…) – pubs.er.usgs.gov/publication/ds1117
Guide to Alaska Geologic and Mineral Information – doi.org/10.14509/3318

DEPARTMENT OF COMMERCE, COMMUNITY, AND ECONOMIC DEVELOPMENT

Minerals Information – www.commerce.alaska.gov/web/ded/dev/mineralsdevelopment
Community and Regional Information – www.commerce.alaska.gov/web/dcra/ResearchAnalysis
Alaska Industrial Development and Export Authority (AIDEA) – www.aidea.org
AIDEA Supports Mining – www.aidea.org/Programs/ProjectDevelopment/35YearsofMiningSupport.aspx

DEPARTMENT OF REVENUE

Mining License Tax – www.tax.alaska.gov/programs/programs/index.aspx?60610
Motor Fuel Tax Claim for Refund – www.tax.alaska.gov//programs/programs/forms/index.aspx?60210
Alaska Motor Fuel Tax Instructions – www.tax.alaska.gov/programs/documentviewer/viewer.aspx?5086f

APPENDIX B

Primary metals production in Alaska, 1880–2019[a]

Year	Gold[b]		Silver		Mercury		Antimony		Tin	
	(oz)	(m$)	(oz)	(t$)	(flask[c])	(t$)	(lb)	(t$)	(lb)	(t$)
1880–99	1,153,889	$23.9	496,101	$329.0	--	--	--	--	--	--
1900–09	6,673,173	137.9	1,324,580	779.5	--	--	--	--	304,000	$112.2
1910–19	7,209,094	149.0	7,058,235	5,107.5	--	--	2,760,000	W	1,640,000	805.9
1920–29	3,373,336	69.8	6,407,375	5,160.8	117	$7.6	W	W	317,800	163.9
1930–39	5,345,205	150.8	3,250,173	1,889.8	31	2.3	1,616,000	$228.3	1,024,400	502.1
1940–49	3,137,447	109.8	794,842	577.0	3,094	724.3	2,062,080	311.1	319,200	230.3
1950–59	2,297,827	80.6	321,669	292.9	18,185	4,370.0	2,663,520	3,697.6	1,144,000	1,310.5
1960–69	751,870	26.6	59,300	70.7	13,996	3,098.0	228,800	267.8	--	--
1970–79	324,906	55.8	54,700	250.5	4,040	1,694.0	1,473,000	1,714.0	166,000	949.0
1980	75,000	32.0	7,500	111.0	--	--	--	--	120,000	984.0
1981	134,200	55.2	13,420	111.3	W	W	--	--	106,000	700.0
1982	175,000	69.9	22,000	198.0	--	--	--	--	198,000	1,365.0
1983	169,000	67.6	33,200	332.0	--	--	22,400	45.0	215,000	1,100.0
1984	175,000	62.1	20,000	159.0	5	1.5	135,000	225.8	225,000	400.0
1985	190,000	61.2	28,500	171.0	27	10.0	65,000	98.0	300,000	650.0
1986	160,000	60.8	24,000	134.4	12	2.8	45,000	67.5	340,000	890.0
1987	229,707	104.5	54,300	391.0	--	--	--	--	288,000	460.0
1988	265,500	112.8	47,790	282.0	W	W	--	--	300,000	950.0
1989	284,617	108.7	5,211,591	27,300.0	--	--	--	--	194,000	672.0
1990	231,700	89.2	10,135,000	50,675.0	--	--	--	--	57,000	200.0
1991	243,900	88.3	9,076,854	39,110.0	--	--	--	--	6,800	22.1
1992	262,530	88.5	9,115,755	34,913.0	--	--	--	--	1,500	5.9
1993	191,265	68.6	5,658,958	24,333.0	--	--	--	--	21,000	50.6
1994	182,100	70.3	1,968,000	10,391.0	--	--	--	--	--	--
1995	141,882	56.0	1,225,730	6,655.0	--	--	--	--	--	--
1996	161,565	62.6	3,676,000	19,078.0	--	--	--	--	--	--
1997	590,516	207.3	14,401,165	70,710.0	--	--	--	--	--	--
1998	594,191	174.6	14,856,000	82,154.0	--	--	--	--	--	--
1999	517,890	144.3	16,467,000	85,628.0	--	--	--	--	--	--
2000	551,982	154.1	18,226,615	90,404.0	--	--	--	--	--	--
2001	550,644	149.3	16,798,000	73,408.0	--	--	--	--	--	--
2002	562,094	174.3	17,858,183	82,326.0	--	--	--	--	--	--
2003	528,191	191.9	18,589,100	95,300.0	--	--	--	--	--	--
2004	456,508	192.3	16,947,270	113,056.9	--	--	--	--	--	--
2005	427,031	189.9	11,670,000	85,382.0	--	--	--	--	--	--
2006	570,129	344.1	16,489,394	190,415.9	--	--	--	--	--	--
2007	726,933	511.1	20,203,985	270,402.1	--	--	--	--	--	--
2008	800,752	698.2	14,643,735	219,496.4	--	--	--	--	--	--
2009	780,657	759.1	15,617,436	229,159.3	--	--	--	--	--	--
2010	914,462	1,119.8	13,991,297	282,523.5	--	--	--	--	--	--
2011	848,945	1,334.1	11,683,967	410,340.9	--	--	--	--	--	--
2012	921,240	1,537.5	12,313,877	383,573.6	--	--	--	--	--	--
2013	1,022,987	1,551.9	13,453,367	320,121.0	--	--	--	--	--	--
2014	948,547	1,201.2	15,388,901	304,392.5	--	--	--	--	--	--
2015	941,394	1,013.9	15,147,249	237,508.9	--	--	--	--	--	--
2016	909,242	1,119.3	16,621,035	246,109.8	--	--	--	--	--	--
2017	859,631	1,064.0	16,085,142	274,163.2	--	--	--	--	--	--
2018	711,986	888.3	15,116,355	210,826.8	--	--	--	--	--	--
2019	589,080	802.5	17,674,583	258,052.1	--	--	--	--	--	--
Other[e]	489,537	--	--	--	1,438	--	--	--	--	--
Total	**50,354,283**	**$17,585.5**	**426,329,229**	**$4,844,257.4**	**40,945**	**$9,910.5**	**11,070,800**	**$6,655.1**	**7,287,700**	**$12,523.5**

t$ = thousands of dollars m$ = millions of dollars -- = Not reported
W = withheld

[a]From published and unpublished State and Federal documents. Where State and Federal figures differ significantly, State figures are used. Please refer to previous editions of this appendix for year-to-year production information for years 1900 to 1979.

[b]Gold production adjusted to be more consistent with mining district production totals.

[c]76-lb flask.

[d]Crude platinum; total production of refined metal is about 575,000 oz.

[e]Not traceable by year

APPENDIX B, CONTINUED

Primary metals production in Alaska, 1880–2019[a]

Year	Lead		Zinc		Platinum[d]		Copper		Chromium	
	(tons)	(t$)	(tons)	(t$)	(oz)	(t$)	(lb)	(m$)	(tons)	(t$)
1880–99	250	$ 17.0	--	--	--	--	--	--	--	--
1900–09	369	32.8	--	--	--	--	29,549,486	$ 4.8	--	--
1910–19	3,565	470.2	--	--	914	$116.5	515,253,817	109.9	2,200	W
1920–29	7,961	1,084.1	--	--	5,750	484.9	643,576,929	93.3	--	--
1930–39	10,791	914.3	--	--	102,615	5,427.1	184,522,000	19.5	--	--
1940–49	3,096	405.2	678	$ 0.5	225,285	12,623.3	433,700	0.2	7,409	$ 250.9
1950–59	177	38.6	--	--	107,927	9,403.9	106,000	0.1	21,442	1,975.8
1960–69	40	9.9	--	--	111,556	13,618.5	352,000	0.1	--	--
1970–79	20	8.0	--	--	41,604	6,826.0	--	--	8,000	1,200.0
1980	31	29.0	--	--	--	--	--	--	--	--
1981	--	--	--	--	900	200.0	--	--	--	--
1982	--	--	--	--	W	W	--	--	--	--
1983	--	--	--	--	W	W	--	--	--	--
1984	--	--	--	--	W	W	--	--	--	--
1985	--	--	--	--	--	--	--	--	--	--
1986	--	--	--	--	W	W	--	--	--	--
1987	--	--	--	--	W	W	--	--	--	--
1988	--	--	--	--	25	13.8	--	--	--	--
1989	9,585	7,700.0	19,843	29,400.0	--	--	--	--	--	--
1990	44,220	30,954.0	181,200	253,680.0	--	--	--	--	--	--
1991	69,591	33,403.7	278,221	278,221.0	15	5.3	--	--	--	--
1992	68,664	31,585.0	274,507	301,957.7	--	--	--	--	--	--
1993	38,221	13,759.6	268,769	236,516.7	3	1.2	--	--	--	--
1994	36,447	25,512.9	329,003	296,102.7	5	2.1	--	--	--	--
1995	58,098	34,428.6	359,950	345,552.0	1	0.4	--	--	--	--
1996	70,086	52,284.0	366,780	361,646.0	2	0.8	780,000	0.8	--	--
1997	88,560	49,593.0	419,097	494,888.0	--	--	3,440,000	3.5	--	--
1998	102,887	49,386.0	549,348	505,400.0	--	--	3,800,000	2.9	--	--
1999	125,208	57,596.0	643,642	630,769.0	--	--	4,200,000	3.0	--	--
2000	123,224	51,754.0	669,112	682,494.0	--	--	2,800,000	2.3	--	--
2001	127,385	56,049.0	634,883	507,907.0	--	--	2,800,000	2.0	--	--
2002	146,462	61,514.0	718,103	502,674.0	--	--	3,200,000	2.3	--	--
2003	162,479	64,279.0	714,769	536,348.0	--	--	--	--	--	--
2004	150,796	120,636.8	680,015	651,432.2	--	--	--	--	--	--
2005	131,366	115,230.0	684,462	862,108.0	--	--	--	--	--	--
2006	157,128	183,629.3	673,967	2,002,971.4	--	--	--	--	--	--
2007	167,181	389,532.2	696,115	2,048,451.6	--	--	87,627	0.3	--	--
2008	153,705	287,428.4	626,135	1,055,220.1	--	--	--	--	--	--
2009	167,204	260,838.2	712,496	1,068,744.0	--	--	--	--	--	--
2010	146,480	284,171.2	667,539	1,212,390.3	--	--	--	--	--	--
2011	113,649	247,755.2	696,793	1,379,649.2	5,000	8,609.3	1,058	0.0	--	--
2012	126,234	234,795.2	647,481	1,139,566.6	--	--	14,327	0.0	--	--
2013	126,707	245,811.6	665,318	1,157,653.3	--	--	77,240	0.3	--	--
2014	155,183	294,847.2	716,781	1,404,890.4	--	--	--	--	--	--
2015	151,247	245,126.5	686,938	1,204,315.0	--	--	--	--	--	--
2016	155,409	241,931.4	700,376	1,250,186.4	--	--	--	--	--	--
2017	140,683	288,118.8	649,889	1,639,020.1	--	--	--	--	--	--
2018	127,427	252,176.4	698,218	1,851,779.3	--	--	--	--	--	--
2019	133,424	233,202.7	665,889	1,486,129.0	--	--	--	--	--	--
Other[e]	--	--	--	--	71,946	17,091.9	--	--	--	--
Total	**3,601,240**	**$4,548,038.9**	**17,296,317**	**$27,378,063.5**	**673,548**	**$57,333.1**	**1,394,994,184**	**$245.3**	**39,051**	**$3,426.7**

t$ = thousands of dollars m$ = millions of dollars -- = Not reported
W = withheld

[a]From published and unpublished State and Federal documents. Where State and Federal figures differ significantly, State figures are used. Please refer to previous editions of this appendix for year-to-year production information for years 1900 to 1979.

[b]Gold production adjusted to be more consistent with mining district production totals.

[c]76-lb flask.

[d]Crude platinum; total production of refined metal is about 575,000 oz.

[e]Not traceable by year

APPENDIX C

Production of industrial minerals, coal, and other commodities in Alaska, 1880–2019[a,b]

Year	Coal		Sand and Gravel[c]		Rock[d]		Barite		Other[e]
	short tons	m$	short tons	m$	short tones	m$	short tons	t$	$
1880–99	19,429	$0.1	--	--	7,510	--	--	--	--
1900–09	33,214	0.2	--	--	15,318	--	--	--	$246,403
1910–19	210,806	1.2	--	--	50,014	--	--	--	2,014,788
1920–29	937,860	5.2	--	--	494,417	--	--	--	2,523,754
1930–39	1,222,797	5.5	42,332	$0.0	689,676	--	--	--	899,767
1940–49	3,189,026	20.2	1,758,504	0.7	286,341	--	--	--	27,124,158
1950–59	6,632,641	59.7	65,804,686	55.1	1,843,560	--	--	--	25,443,427
1960–69	7,849,000	58.8	163,315,000	176.7	2,034,000	--	225,000	$1,200.0	34,143,000
1970–79	7,405,000	89.0	489,522,000	1,004.9	47,930,000	--	502,000	8,217.0	77,501,000
1980	800,000	16.0	40,000,000	86.0	3,700,000	--	50,000	2,000.0	97,500
1981	800,000	17.6	46,000,000	88.2	4,200,000	--	--	--	256,000
1982	830,000	18.0	45,000,000	91.0	3,400,000	--	--	--	150,000
1983	830,000	18.0	50,000,000	105.0	5,270,000	--	--	--	242,000
1984	849,161	23.8	27,000,000	95.0	2,700,000	--	--	--	875,875
1985	1,370,000	39.7	28,184,080	112.1	2,500,000	--	--	--	559,000
1986	1,492,707	40.1	20,873,110	75.8	4,200,000	--	--	--	384,800
1987	1,508,927	42.4	16,696,374	42.7	1,805,000	--	--	--	388,400
1988	1,551,162	44.3	17,264,500	48.8	3,600,000	--	--	--	389,000
1989	1,452,353	41.5	14,418,000	39.9	2,914,000	--	--	--	1,492,000
1990	1,576,000	45.0	15,013,500	40.8	3,200,000	--	--	--	400,000
1991	1,540,000	39.0	14,160,011	45.5	3,000,000	--	--	--	462,000
1992	1,531,800	38.3	14,599,746	42.2	2,900,000	--	--	--	430,000
1993	1,586,545	38.1	13,162,402	40.6	3,561,324	--	--	--	465,000
1994	1,490,000	36.8	13,518,321	41.0	3,843,953	--	--	--	459,500
1995	1,640,000	41.3	9,847,550	30.9	2,811,152	--	--	--	182,500
1996	1,481,000	38.0	9,890,463	32.2	3,000,045	--	--	--	200,000
1997	1,446,000	38.1	13,800,000	51.9	3,200,000	--	--	--	217,000
1998	1,339,000	35.2	12,363,450	57.3	1,636,200	--	--	--	215,000
1999	1,560,000	41.1	10,600,000	52.4	1,640,000	--	--	--	190,000
2000	1,473,355	38.8	10,600,000	49.9	5,200,000	--	--	--	203,000
2001	1,537,000	48.1	10,360,000	55.2	3,091,000	--	--	--	205,000
2002	1,158,000	37.4	22,412,000	120.7	3,152,000	--	--	--	200,000
2003	1,088,000	38.1	11,868,001	64.1	861,382	--	--	--	175,000
2004	1,450,000	50.8	19,576,092	101.5	7,312,050	--	--	--	2,732,554
2005	1,402,174	49.1	16,620,009	76.5	2,803,172	--	--	--	809,642
2006	1,397,500	48.9	13,953,465	63.4	2,369,738	--	--	--	1,057,500
2007	1,273,004	44.6	14,163,676	76.1	2,211,954	--	--	--	1,085,500
2008	1,538,000	53.8	12,461,685	72.4	2,485,820	--	--	--	1,159,502
2009	1,861,714	65.2	7,072,037	41.4	1,837,090	--	--	--	3,678,930
2010	2,061,000	72.1	6,977,297	48.0	290,852	--	--	--	2,303,950
2011	2,220,000	77.7	5,862,851	38.7	499,722	--	--	--	3,200,000
2012	2,018,759	70.7	7,799,994	52.3	1,050,762	--	--	--	--
2013	1,600,000	56.0	11,622,045	79.6	364,632	--	--	--	1,900,000
2014	1,500,000	52.5	526,509	6.8	1,147,869	--	--	--	120,000
2015	1,177,390	41.2	5,725,541	17.2	--	--	--	--	--
2016	930,987	32.6	6,123,896	17.3	--	--	--	--	--
2017	873,000	30.6	3,918,110	11.6	--	--	--	--	--
2018	1,000,000	35.0	4,010,671	10.5	--	--	--	--	--
2019	1,000,000	35.0	2,728,570	7.8	--	--	--	--	--
Other	--	--	--	--	2,300,000[f]	W	79,000	W	--
Total	**82,734,311**	**$1,910.0**	**1,347,216,477**	**$3,467.6**	**153,410,553**	**$952.5**	**856,000**	**$11,417.0**	**$196,782,450**

[a]From published and unpublished State and Federal documents. Where State and Federal figures differ significantly, State figures are used.

[b]Please refer to previous editions of this appendix for year-to-year production information for years 1900 to 1979.

[c]As of 2015, rock, sand, and gravel are reported as a combined commodity.

[d]Building-stone production figures for 1880-1937 are for the southcentral and interior regions of Alaska only.

[e]Includes 2.4 million lb U3O8 (1955–1971); 505,000 tons gypsum (1905–1926); 286,000 lb WO3 (intermittently, 1916–1980); 94,000 lb asbestos (1942–44); 540,000 lb graphite (1917–1918 and 1942–1950); and undistributed amounts of zinc, jade, peat, clay, soapstone, miscellaneous gemstones, and other commodities (1880–present).

[f]Marble quarried on Prince of Wales Island, southeastern Alaska (1900–1941).

m$ = millions of dollars t$ = thousands of dollars -- = not reported W = withheld

APPENDIX D

Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																					
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Co %	Co thousdand pounds	$BaSO_4$ %	Barite thousand pounds	TREO %	TREO thousand pounds	Graphite %	Graphite thousand pounds
KENSINGTON — Gold veins — Precious metals (gold) Source: Coeur Reports Year-End 2019 Mineral Reserves and Resources: Coeur Mining news release dated February 18, 2020																					
Production	Proven	898,000							0.200	180.0											
Production	Probable	779,000							0.239	186.0											
Production	Measured	2,062,000							0.239	493.0											
Production	Indicated	1,164,000							0.231	269.0											
Advanced Exploration	Inferred	1,562,000							0.229	358.0											
	Total	**6,465,000**							**0.230**	**1,486.0**											
LMS — Gold veins — Precious metals (gold) Source: NI 43-101 Technical Report on the LMS Gold Project, Goodpaster Mining District, Alaska; 43-101 technical report dated February 19, 2016																					
Exploration (0.5 g/t Au cut-off, open pit)	Inferred	9,170,000							0.029	267.0											
POGO — Gold veins — Precious metals (gold) Source: Northern Star Resources Limited news release dated August 1, 2019																					
Production (includes Probable reserves)	Indicated	7,937,000							0.280	2,226											
Production	Inferred	13,369,000							0.277	3,720											
	Total	**21,306,000**							**0.278**	**5,946**											
TERRA — Gold veins — Precious metals (gold, silver) Source: Technical Report on Resources, Terra Gold Project, McGrath District, Alaska; 43-101 technical report dated February 19, 2013																					
Exploration (5 g/tonne Au cut-off)	Indicated	128,913							0.386	49.8	0.87	112.7									
Exploration (5 g/tonne Au cut-off)	Inferred	811,286							0.456	369.8	0.81	653.9									
	Total	**940,199**							**0.446**	**419.6**	**0.82**	**766.6**									
HERBERT GOLD — Gold veins — Precious metals (gold) Source: Grande Portage Resources Ltd. news release dated May 7, 2019																					
Exploration (0.073 ounce of gold per ton cut-off)	Indicated	2,072,894							0.293	606.5											
Exploration (0.073 ounce of gold per ton cut-off)	Inferred	610,050							0.413	251.7											
	Total	**2,682,944**							**0.320**	**858.2**											
GOLDEN ZONE — Gold veins — Precious metals (gold, silver) Source: Technical Report on the Golden Zone Property, Valdez Creek Mining District, Central Alaska Range, South-Central Alaska; NI 43-101 technical report dated November 23, 2016 / amended August 17, 2017																					
Exploration (0.5 g/tonne Au cut-off)	Indicated	4,615,377							0.058	267.4	0.303	1,397.8									
Exploration (0.5 g/tonne Au cut-off)	Inferred	1,491,427							0.024	35.9	0.075	111.4									
	Total	**6,106,804**							**0.050**	**303.3**	**0.247**	**1,509.2**									
LUCKY SHOT (Willow) — Gold veins — Precious metals (gold) Source: Preliminary Feasibility Study for the Lucky Shot Project, Matanuska-Susitna Borough, Alaska, USA; NI 43-101 technical report dated June 30, 2016																					
Development (7 g/tonne cut-off; subset of measured)	Proven	75,728							0.551	41.7	0.059	4.5									
Development (7 g/tonne cut-off; subset of indicated)	Probable	116,513							0.394	45.8	0.041	4.8									
Exploration (5 g/tonne Au cut-off)	Measured	63,823							0.782	49.9	0.073	4.7									
Exploration (5 g/tonne Au cut-off)	Indicated	163,802							0.438	71.6	0.047	7.4									
Exploration (5 g/tonne Au cut-off)	Inferred	65,036							0.540	35.1	0.044	2.9									
	Total (resources only)	**292,661**							**0.536**	**156.6**	**0.052**	**15.0**									
SHOTGUN — Gold veins — Precious metals (gold) Source: Technical Report on the Shotgun Gold Project, Southwest Alaska; NI 43-101 technical report dated May 27, 2013																					
Exploration (0.015 ounce of Au/ton cut-off)	Inferred	22,860,000							0.031	706.0											
	Total	**22,860,000**							**0.031**	**706.0**											
DONLIN — Intrusion gold — Precious metals (gold) Source: NovaGold Resources, Inc. Donlin Creek Gold Project, Alaska, USA, NI 43-101 Technical Report on Second Updated Feasibility Study; dated November 18, 2011, amended January 20, 2012																					
Development	Proven	8,468,971							0.068												
Development	Probable	547,984,194							0.061	33,276.0											
Development	Measured	52,910							0.074	53.0											
Development	Indicated	40,210,802							0.065	5,104.0											
Development	Inferred	101,649,697							0.059	5,993.0											
	Total	**698,366,574**							**0.061**	**45,000.0**											

APPENDIX D, CONTINUED

Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																					
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Co %	Co thousdand pounds	$BaSO_4$ %	Barite thousand pounds	TREO %	TREO thousand pounds	Graphite %	Graphite thousand pounds
FORT KNOX — Intrusion gold — Precious metals (gold) Source: Kinross Gold Corp. news release dated February 12, 2020																					
Production	Proven	48,482,000							0.012	541											
Production	Probable	233,500,000							0.009	2,260											
Production	Measured	7,352,000							0.012	80											
Production	Indicated	187,462,000							0.012	1,946											
Production	Inferred	94,858,000							0.009	774											
	Total	**571,654,000**							**0.010**	**5,601**											
GIL — Intrusion gold — Precious metals (gold) Source: Fort Knox Mine, Fairbanks North Star Borough, Alaska, USA; NI 43-101 technical report dated June 11, 2018; effective date: December 31, 2017																					
Exploration	Indicated	32,535,782							0.016	533.0											
Exploration	Inferred	4,438							0.014	63.0											
	Total	**32,540,220**							**0.016**	**596.0**											
GOLDEN SUMMIT — Intrusion gold – Precious metals (gold) Source: Golden Summit Project Preliminary Economic Assessment, Fairbanks North Star Borough, Alaska, USA; NI 43-101 technical report dated January 20, 2016																					
Exploration (Dolphin oxide deposit; 0.30 g/tonne cut-off)	Indicated	17,835,214							0.019	345.0											
Exploration (Dolphin oxide deposit; 0.30 g/tonne cut-off)	Inferred	10,604,126							0.017	183.0											
Exploration (Dolphin sulfide deposit; 0.30 g/tonne cut-off)	Indicated	49,912,144							0.020	1,018.0											
Exploration (Dolphin sulfide deposit; 0.30 g/tonne cut-off)	Inferred	68,210,324							0.020	1,401.0											
	Total	**146,561,808**							**0.020**	**2,947.0**											
MONEY KNOB (Livengood) — Intrusion gold — Precious metals (gold) Source: Pre-Feasibility Study of the Livengood Gold Project, Livengood, Alaska, USA; NI 43-101 technical report dated March 8, 2017																					
Advanced Exploration	Proven	416,287,867							0.021	8,620.0											
Advanced Exploration	Probable	15,443,381							0.021	353.0											
Advanced Exploration	Measured	131,935,640							0.020	2,220.8											
Advanced Exploration	Indicated	15,465,428							0.020	267.3											
Advanced Exploration	Inferred	58,202,037							0.019	1,127.2											
	Total	**637,334,353**							**0.020**	**12,588.4**											
NIXON FORK — Intrusion gold (skarn) — Precious metals (gold) Source: Technical Report on the Nixon Fork Mine Project, Medfra Quadrangle, Alaska; NI 43-101 technical report dated February 3, 2012																					
Development (past producer; lode, 5 g/tonne cut-off)	Indicated	270,427							0.481	130.0											
Development (past producer; lode, 5 g/tonne cut-off)	Inferred	118,200							0.512	60.5											
Development (past producer; tailings, 5 g/tonne cut-off)	Indicated	101,412							0.230	23.3											
Development (past producer; tailings, 5 g/tonne cut-off)	Inferred	52,910							0.210	11.4											
	Total	**542,949**							**0.414**	**225.2**											
VINASALE — Intrusion gold — Precious metals (gold) Source: Technical Report for the Vinasale Mountain Prospect, McGrath Mining District, Alaska; 43-101 technical report dated March 31, 2013																					
Exploration	Indicated	3,760,000							0.043	162.0											
Exploration	Inferred	55,340,000							0.031	1,703.0											
	Total	**59,100,000**							**0.032**	**1,865.0**											
ILLINOIS CREEK — Intrusion gold-silver-copper — Precious metals (gold, silver) Source: Western Alaska Copper and Gold website (https://www.wacg.rocks/projects/illinois-creek/; accessed August 31, 2020)																					
Advanced Exploration	Indicated	7,450,000	0.18	26,820					0.030	226.0	1.00	7,500									
Advanced Exploration	Inferred	2,240,000	0.22	9,856					0.031	70.0	1.13	2,500									
	Total	**9,690,000**	**0.19**	**36,676**					**0.031**	**296.0**	**1.03**	**10,000**									

APPENDIX D, CONTINUED

Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite / Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Co %	Co thousand pounds	$BaSO_4$ %	Barite thousand pounds	TREO %	TREO thousand pounds	Graphite %	Graphite thousand pounds
NAOSI — Intrusion gold — Precious metals (gold) Source: Internal resource calculation presented to the American Exploration and Mining Association annual meeting, December 2019.																						
Oxide (0.0225 oz/ton cut-off)	Inferred	8,695,000							0.079	691.0	1.14	9,902										
Sulfide (0.0140 oz/ton cut-off)	Inferred	6,573,000							0.123	811.0	1.44	9,469										
	Total	**15,268,000**							**0.103**	**1,502**	**1.29**	**19,371**										
DELTA — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Bedrock Geologic Map of the Delta Mineral Belt, Tok Mining District, Alaska (DGGS PR 122); 2003																						
Exploration (DW/Mid/Nunatak/LP)	Inferred	9,400,000	0.4	75,200	1.75	329,000	4.61	866,680	0.047	441.9	1.85	17,402										
Exploration (PP2)	Inferred	5,900,000	0.4	47,200	2.1	247,800	4.6	542,800	0.050	292.9	2.07	12,232										
Exploration (DDS)	Inferred	2,300,000	1.1	50,600	2.6	119,600	6.5	299,000	0.070	161.2	2.98	6,850										
Exploration (DDN)	Inferred	1,200,000	1.6	38,400	2.4	57,600	2.3	55,200	0.093	112.1	2.98	3,574										
	Total	**18,800,000**	**0.6**	**211,400**	**1.9**	**754,000**	**4.5**	**1,763,680**	**0.048**	**1,008.1**	**1.96**	**40,058**										
RED MOUNTAIN/BONNIFIELD — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Maiden JORC Mineral Resource at White Rock's Red Mountain zinc-silver Project, Alaska; White Rock Minerals Ltd. news release April 26, 2017																						
Exploration (Dry Creek; 3% Zn-equivalent cut-off)	Inferred	2,645,547	0.2	11,023	1.9	101,403	4.7	253,532	0.012	32.0	2.01	5,300										
Exploration (West Tundra Flats; 3% Zn-equivalent cut-off)	Inferred	7,385,486	0.1	15,432	2.8	414,469	6.2	917,123	0.032	229.0	5.51	40,800										
	Total	**10,031,033**	**0.1**	**26,455**	**2.6**	**515,872**	**5.8**	**1,170,655**	**0.027**	**261.0**	**4.59**	**46,100**										
GREENS CREEK — Massive sulfide — Polymetallic (lead, zinc, gold, silver) Source: Hecla news release dated February 5, 2020																						
Production	Proven	7,000			2.60	360	5.40	780	0.080	1.0	14.80	106										
Production	Probable	10,713,000			2.80	610,020	7.30	1,556,040	0.090	932.0	12.20	130,791										
Production	Measured	76,000			2.60	4,000	9.40	14,280	0.090	7.0	12.50	949										
Production	Indicated	8,569,000			2.80	484,020	8.10	1,383,500	0.100	828.0	11.70	100,187										
Production	Inferred	1,848,000			3.10	113,340	7.40	271,760	0.090	159.0	13.70	25,393										
	Total	**21,213,000**			**2.83**	**1,211,740**	**7.64**	**3,226,360**	**0.094**	**1,927.0**	**12.13**	**257,426**										
NIBLACK — Massive sulfide — Polymetallic (copper, zinc, gold, silver) Source: Mineral Resource Estimation, Niblack Polymetallic Sulfide Project, Alaska, U.S.A.; technical report dated December 5, 2011																						
Advanced Exploration (Lookout deposit)	Indicated	6,215,000	0.95	118,085			1.73	215,039	0.051	318.0	0.86	5,357										
Advanced Exploration (Lookout deposit)	Inferred	2,612,000	0.73	38,135			1.17	61,121	0.041	108.0	0.63	1,650										
Advanced Exploration (Trio deposit)	Inferred	1,128,000	1.00	22,560			1.56	35,194	0.032	37.0	0.48	545										
	Total	**9,955,000**	**0.81**	**178,780**			**1.29**	**311,354**	**0.039**	**384.0**	**0.59**	**5,843**										
PALMER — Massive sulfide — Polymetallic (copper, zinc, gold, silver) Source: NI 43-101 Technical Report and Updated Resource Estimate to include the AG Zone for the Palmer Exploration Project, Porcupine Mining District, Southeast Alaska, USA; effective date: December 18, 2018																						
Exploration (RW & South Wall Zones; $75/tonne cut-off)	Indicated	5,155,504	1.49	154,000			5.23	539,000	0.009	45.1	0.899	4,600					23.9	2,464,765				
Exploration (RW & South Wall Zones; $75/tonne cut-off)	Inferred	5,884,131	0.96	113,000			5.20	612,000	0.008	48.1	0.853	5,000					22.0	2,588,224				
Exploration (AG Zone; 5.0% zinc-equivalent cut-off)	Inferred	4,691,431	0.12	11,000	0.96	90,000	4.64	435,000	0.016	72.5	3.489	16,400					34.8	3,262,838				
	Total	**15,731,066**	**0.9**	**278,000**	**0.3**	**90,000**	**5.04**	**1,586,000**	**0.011**	**166**	**1.65**	**26,000**					**26.4**	**8,315,827**				
JOHNSON TRACT — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Historical resource from Westmin Resources Ltd., 1994, Johnson River Project, Property Prefeasibility, Technical Report, v. 1-4; cited in HighGold Mining Inc. NI 43-101 report dated June 27, 2019.																						
Exploration	Inferred	1,140,891	0.75	17,113	1.13	25,784	8.32	189,844	0.293	334.8	0.22	254										
RED DOG — Massive sulfide — Base metals (lead, zinc, silver) Source: Reserves and resouces as of December 31, 2019. www.teck.com/investors/reserves-&-resources, accessed on August 31, 2020																						
Production (Aqqaluk, Qanaiyaq)	Probable	56,107,000			3.6	2,028,250	12.9	11,838,809			1.98	69,430										
Production (Aqqaluk, Qanaiyaq)	Indicated	7,275,000			3.0	436,500	9.0	1,309,500			1.62	11,790										
Production (Aqqaluk, Qanaiyaq)	Inferred	12,015,000			6.0	1,441,800	11.1	2,667,330			3.27	39,259										
	Total	**75,397,000**			**3.9**	**3,906,550**	**12.2**	**15,815,639**			**2.15**	**120,479**										

APPENDIX D, CONTINUED

Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																				
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Co %	Co thousand pounds	$BaSO_4$ %	Barite thousand pounds	TREO %	TREO thousand pounds	Graphite %	Graphite thousand pounds
ANARRAAQ — Massive sulfide — Base metals (lead, zinc, silver) Source: NI 43-101 Technical Report, Red Dog Mine, Alaska, USA; report dated February 21, 2017																				
Exploration	Inferred	21,428,906			4.2	1,800,028	14.4	6,171,525			2.13	45,626								
ANARRAAQ — Bedded Barite — Barite: Source: King et al., 2002, A summary of ongoing research in the Red Dog district and possible applications to exploration, in Large et al., eds.: Stratiform Zn-Pb-Ag Deposits and Geological Environments, with Emphasis on the Aust. and N. Am. Giants: SEG/PDAC Workshop, Toronto, 2002, 6 p.																				
Exploration	Inferred	1,100,000,000																		
LIK — Massive sulfide — Base metals (lead, zinc, silver) Source: Preliminary Economic Assessment Technical Report, Zazu Metals Corporation, Lik Deposit, Alaska; dated April 23, 2014																				
Advanced Exploration (Lik South, in pit, 5% Zn+Pb cut-off)	Indicated	18,570,000			2.70	1,003,000	8.04	2,986,000			1.463	27,170								
Advanced Exploration (Lik North, in pit, 5% Zn+Pb cut-off)	Indicated	490,000			2.77	27,000	10.03	98,000			1.723	840								
Advanced Exploration (Lik South, other, 7% Zn+Pb cut-off)	Indicated	760,000			3.15	48,000	8.04	122,000			1.489	1,130								
Advanced Exploration (Lik North, other, 7% Zn+Pb cut-off)	Indicated	140,000			2.93	8,000	8.93	25,000			1.095	150								
Advanced Exploration (Lik South, in pit, 5% Zn+Pb cut-off)	Inferred	820,000			1.94	32,000	7.73	127,000			0.391	320								
Advanced Exploration (Lik North, in pit, 5% Zn+Pb cut-off)	Inferred	2,350,000			2.94	138,000	8.88	417,000			1.337	3,140								
Advanced Exploration (Lik South, other, 7% Zn+Pb cut-off)	Inferred	560,000			1.59	18,000	6.97	78,000			0.330	180								
Advanced Exploration (Lik North, other, 7% Zn+Pb cut-off)	Inferred	2,160,000			2.99	129,000	9.22	398,000			1.337	2,890								
	Total	**25,850,000**			**2.72**	**1,403,000**	**8.23**	**4,251,000**			**1.163**	**35,820**								
ARCTIC — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Arctic Project, Northwest Alaska, USA NI 43-101 Technical Report on Pre-Feasibility Study; dated February 20, 2018																				
Advanced Exploration (in pit, 0.5% Cu-equivalent cut off)	Probable	47,441,218	2.32	2,201,273	0.57	540,830	3.24	3,074,191	0.014	678.8	1.05	49,870								
Advanced Exploration (in pit, 0.5% Cu-equivalent cut off)	Inferred	3,858,085	1.71	131,000	0.60	47,000	2.72	210,000	0.011	40.0	0.84	3,000								
	Total	**51,299,303**	**2.27**	**2,332,273**	**0.57**	**587,830**	**3.20**	**3,284,191**	**0.014**	**718.8**	**1.04**	**52,870**								
BORNITE — Massive sulfide — Polymetallic (carbonate-hosted copper, cobalt) Source: NI 43-101 Technical Report on the Bornite Project, Northwest Alaska, USA; report dated June 5, 2018																				
Exploration (in pit, 0.5% Cu cut-off)	Indicated	44,643,555	1.02	913,000																
Exploration (in pit, 0.5% Cu cut-off)	Inferred	92,704,271	0.95	1,768,000											**0.017**	**45,000**				
Exploration (below pit, 1.5% Cu cut-off)	Inferred	63,713,518	2.89	3,683,000											**0.025**	**32,000**				
	Total	**201,061,344**	**1.58**	**6,364,000**											**0.020**	**77,000**				
SUN — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Technical Report on the Sun Project, Brooks Range, Alaska; NI 43-101 technical report dated September 30, 2013																				
Exploration ($75/tonne cut-off)	Indicated	2,386,501	1.42	67,620	1.06	50,585	4.11	196,098	0.006	14.0	1.68	4,008								
Exploration ($75/tonne cut-off)	Inferred	12,839,707	1.14	292,671	1.37	351,247	3.91	1,004,947	0.007	89.0	2.24	28,776								
	Total	**15,226,208**	**1.18**	**360,291**	**1.32**	**401,832**	**3.94**	**1,201,045**	**0.007**	**103**	**2.15**	**32,784**								
SMUCKER — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Historical resource from Anaconda Copper Mining Company, Internal Report, 1981; cited in Trilogy Metals news release dated March 19, 2019.																				
Exploration	Inferred	12,786,796	0.95	242,949	2.3	588,193	6.4	1,636,710	0.025	324.8	4.78	61,084								

APPENDIX D, CONTINUED

Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																				
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Co %	Co thousand pounds	$BaSO_4$ %	Barite thousand pounds	TREO %	TREO thousand pounds	Graphite %	Graphite thousand pounds
HORSE CREEK — Massive sulfide — Polymetallic (copper, lead, zinc, silver) Source: Historical resource from Kennecott Mines Company, Internal Report, 1985; cited in Trilogy Metals news release dated March 19, 2019.																				
Exploration	Inferred	11,023,100	1.00	220,462	2	440,924	3	661,386			0.91	9,978								
SUNSHINE — Massive sulfide — Polymetallic (copper, lead, zinc, silver) Source: Historical resource from Kennecott Mines Company, Internal Report, 1997; cited in Trilogy Metals news release dated March 19, 2019.																				
Exploration	Inferred	22,046,200	1.40	617,294	0.5	220,462	2.5	1,102,310			0.76	16,802								
SHUNGNAK — Massive sulfide — Polymetallic (copper, zinc, silver) Source: Historical resource from Bear Creek Mining Company, Internal Report, 1983; cited in Trilogy Metals news release dated March 19, 2019.																				
Exploration	Inferred	1,102,310	3.00	66,139			2	44,092			1.82	2,002								
BT — Massive sulfide — Polymetallic (copper, lead, zinc, silver) Source: Historical resource from Kennecott Mines Company, Internal Report, 1997; cited in Trilogy Metals news release dated March 19, 2019.																				
Exploration	Inferred	3,858,085	1.70	131,175	**0.9**	**69,446**	**2.6**	**200,620**			1.18	4,551								
CARIBOU DOME — Sediment-hosted — Base metals (copper) Source: High-Grade Initial JORC Resource Estimate -- Caribou Dome; Coventry Resources news release dated April 5, 2017																				
Advanced Exploration (0.5% Cu cut-off)	Measured	627,214	3.6	46,297																
Advanced Exploration (0.5% Cu cut-off)	Indicated	653,670	2.2	28,660																
Advanced Exploration (0.5% Cu cut-off)	Inferred	1,801,175	3.2	114,639																
	Total	**3,082,059**	**3.1**	**189,596**																
PEBBLE — Porphyry — Polymetallic (copper, gold, silver, molybdenum) Source: https://www.northerndynastyminerals.com/pebble-project/reserves-resources/; accessed August 31, 2018																				
Advanced Exploration (0.3 CuEq cut-off)	Measured	580,912,100	0.33	3,830,000					0.010	5,930	0.050	28,100	0.0178	210,000						
Advanced Exploration (0.3 CuEq cut-off)	Indicated	6,535,536,700	0.41	53,580,000					0.010	64,810	0.050	316,400	0.0246	3,200,000						
Advanced Exploration (0.3 CuEq cut-off)	Inferred	4,909,644,200	0.25	24,540,000					0.007	35,800	0.035	170,400	0.0226	2,180,000						
	Total	**12,026,093,000**	**0.341**	**81,950,000**					**0.009**	**106,540**	**0.044**	**514,900**	**0.0235**	**5,590,000**						
PYRAMID — Porphyry — Polymetallic (copper, gold, molybdenum) Source: NI 43-101 Technical Report for the Pyramid Project, Alaska Peninsula, Alaska; report dated January 2018																				
Main Zone (0.20% Cu-equivalent cut-off)	Inferred	155,315,479	0.38	1,186,000					0.003	442.0			0.022	68,000						
West Zone (0.20% Cu-equivalent cut-off)	Inferred	13,778,875	0.28	76,000					0.002	14.0			0.010	2,000						
	Total	**169,094,354**	**0.37**	**1,262,000**					**0.003**	**456.0**			**0.021**	**70,000**						
SHUMAGIN (UNGA PROJECT)— Epithermal — Precious metals (gold, silver) Source: Historical resource estimate by Strandberg (1995) cited in Redstar Resources technical report on the Unga project, Southwest Alaska, USA; report dated June 14, 2018																				
Exploration	Inferred	280,335							0.800	224.0	3.65	1,025.0								
CENTENNIAL (UNGA PROJECT)— Epithermal — Precious metals (gold, silver) Source: Historical resource estimate by Battle Mountain Gold Company (1989), cited in Redstar Resources technical report on the Unga project, Southwest Alaska, USA; report dated June 14, 2018																				
Exploration	Inferred	4,780,000							0.042	200.0										
TETLIN — Main and North Peak Skarn — Polymetallic (copper, gold, silver) Source: Royale Gold news release dated September 24, 2018																				
Exploration (0.74, 0.66 g/tonne Au-equiv. cut-off: Main, North)	Measured	521,393	0.148	1,500					0.187	97.1	0.488	254.0								
Exploration (0.74, 0.66 g/tonne Au-equiv. cut-off: Main, North)	Indicated	9,620,962	0.153	29,500					0.116	1,110.9	0.411	3,944.8								
Exploration (0.5 g/tonne Au-equivalent cut-off?)	Inferred	1,481,505	0.151	31,000					0.079	116.4	0.469	694.1								
	Total	**11,623,859**	**0.153**	**62,000**					**0.114**	**1,324.4**	**0.421**	**4,892.9**								
RAINTREE WEST — Porphyry — Polymetallic (copper, gold, silver) Source: NI 43-101 Resource Estimate for the Whistler Project; report dated March 24, 2016																				
Exploration (0.3 g/tonne Au-equivalent cut-off)	Inferred (above 250m)	34,921,181	0.06	41,910					0.012	409.0	0.157	5,490								
Exploration (0.3 g/tonne Au-equivalent cut-off)	Inferred (below 100m)	57,055,566	0.10	114,130					0.020	1,130.0	0.109	6,224								
	Total	**91,976,746**	**0.08**	**156,040**					**0.017**	**1,539.0**	**0.127**	**12,544**								

APPENDIX D, CONTINUED

Identified mineral resources of Alaska deposits

Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Co %	Co thousdand pounds	$BaSO_4$ %	Barite thousand pounds	TREO %	TREO thousand pounds	Graphite %	Graphite thousand pounds
DEPOSIT—Type—Metal Suite																						
ISLAND MOUNTAIN — Porphyry — Polymetallic (copper, gold, silver) Source: NI 43-101 Resource Estimate for the Whistler Project; report dated March 24, 2016																						
Exploration (0.3 g/tonne Au-equivalent cut-off)	Indicated	34,259,795	0.06	41,120					0.014	485.0	0.032	1,099										
Exploration (0.3 g/tonne Au-equivalent cut-off)	Inferred	90,411,466	0.05	90,430					0.014	1,237.0	0.030	2,690										
	Total	**124,671,261**	**0.05**	**131,550**					**0.014**	**1,722.0**	**0.030**	**3,789**										
WHISTLER — Porphyry — Polymetallic (copper, gold, silver) Source: NI 43-101 Resource Estimate for the Whistler Project; report dated March 24, 2016																						
Exploration (Pit-con-strained; $7.50/tonne cut-off)	Indicated	87,300,000	0.17	302,000					0.015	1,280.0	0.057	5,030										
Exploration (Pit-con-strained; $7.50/tonne cut-off)	Inferred	160,700,000	0.15	467,000					0.012	1,850.0	0.051	8,210										
	Total	**248,000,000**	**0.16**	**769,000**					**0.013**	**3,130.0**	**0.053**	**13,240.0**										
ZACKLY — Skarn — Polymetallic (copper, gold) Source: JORC-compliant resource, PolarX news release dated March 20, 2018																						
Exploration	Inferred	3,747,854	1.2	90,900					0.058	213	0.409	1,500										
QUARTZ HILL — Porphyry — (Molybdenum) Source: Mineral investigations in the Ketchikan mining district, southeastern Alaska: U.S. Bureau of Mines Open-File Report 11-95 (1995)																						
Exploration	"Probable resource"	444,000,000											0.219	978,851,280								
Exploration	"Possible resource"	1,360,000,000											0.136	2,998,283,200								
	Total	**1,804,000,000**											**0.156**	**3,977,134,480**								
BOKAN MOUNTAIN — Other (Intrusion hosted) — Other (rare-earth elements) Source: Ucore Increases Resource at Bokan Dotson-Ridge; Ucore Rare Metals news release May 11, 2015																						
Advanced Exploration (Dotson trend, 0.4% TREO cut-off)	Indicated	5,278,000																	0.602	63,544		
Advanced Exploration (Dotson trend, 0.4% TREO cut-off)	Inferred	1,157,000																	0.603	13,959		
	Total	6,435,000																	**0.602**	**77,503**		
GRAPHITE CREEK — Other — Other (graphite) Source: Graphite One news release dated May 26, 2019																						
Exploration (5.0% Cg cut-off)	Measured	1,860,000																			8.0	298,001
Exploration (5.0% Cg cut-off)	Indicated	10,200,000																			7.7	1,577,104
Exploration (5.0% Cg cut-off)	Inferred	101,300,000																			8.0	16,188,267
	Total	**113,360,000**																			**7.8**	**18,063,372**
LAKEVIEW, LONGVIEW — Other (stratiform barite) Source: Schmidt and others, 2009, The Longview/Lakeview barite deposits, southern National Petroleum Reserve, Alaska; potential-field models and preliminary size estimates, U.S. Geological Survey Professional Paper 1760-C, 29 p. [http://pubs.usgs.gov/pp/1760/c/]																						
Exploration (min. 4.5M tonnes; possibly >38 M tonnes)	Inferred	4,960,395															93	1,150,626				

Data in this table were collected from publicly available company reports, company press releases, and government publications.

APPENDIX E
Conversion Chart, U.S. Customary Units/Metric Units

Weight/Mass/Ore Content		
To convert from:	**to:**	**multiply by:**
ounces (avoirdupois)	grams	28.3495
ounces (troy)	grams	31.1035
pounds	kilograms	0.4536
short tons	metric tons (tonnes)	0.9072
grams	ounces (avoirdupois)	0.03527
grams	ounces (troy)	0.03215
kilograms	pounds	2.20462
metric tons (tonnes)	short tons	1.10231
parts per million (ppm)	parts per billion (ppb)	1,000
parts per million (ppm)	ounces per ton	0.0292
parts per million (ppm)	grams/metric tons (tonnes)	1.00

Area		
To convert from:	**to:**	**multiply by:**
square miles	square kilometers	2.59
square miles	acres	640
acres	square meters	4,046.86
acres	hectares	0.40486
square yards	square meters	0.836127
square feet	square meters	0.092903
square inches	square centimeters	6.4516
square inches	square millimeters	645.16
square meters	acres	0.000247105
square kilometers	acres	247.105
square kilometers	square miles	0.386102
square meters	square feet	10.7639
square meters	square yards	1.19599
hectares	acres	2.47105
hectares	square meters	10,000
square centimeters	square inches	0.155
square millimeters	square inches	0.00155

APPENDIX E, CONTINUED

Conversion Chart, U.S. Customary Units/Metric Units

Length		
To convert from:	**to:**	**multiply by:**
miles	kilometers	1.60934
miles	yards	1,760
miles	meters	1,609.34
yards	meters	0.9144
feet	meters	0.3048
feet	centimeters	30.48
feet	millimeters	304.8
inches	centimeters	2.54
inches	millimeters	25.4
kilometers	miles	0.621371
meters	yards	1.09361
meters	feet	3.28084
millimeters	feet	0.00328
millimeters	inches	0.03937
centimeters	inches	0.3937

Volume		
To convert from:	**to:**	**multiply by:**
cubic yards	cubic meters	0.764555
cubic feet	cubic meters	0.0283168
cubic inches	cubic centimeter	16.3871
cubic meters	cubic yards	1.30795
cubic meters	cubic feet	35.3147
cubic centimeters	cubic inches	0.0610237
gallons (U.S.)	liters	3.78541
liters	gallons (U.S.)	0.264172
milliliters	ounces (fluid)	0.033814
ounces (fluid)	milliliters	29.5735

Temperature		
To convert from:	**to:**	**do this:**
degrees Fahrenheit	degrees Celsius	subtract 32, multiply by 5, divide by 9
degrees Celsius	degrees Fahrenheit	multiply by 9, divide by 5, add 32

Source: google.com unit converter.

	Mining districts[a]	Production (in refined troy ounces) Total	Placer	Lode
1	Lisburne district	0	0	0
2	Noatak district	7,800	7,800	0
3	Wainwright district	0	0	0
4	Barrow district	0	0	0
5	Colville district	0	0	0
6	Canning district	0	0	0
7	Sheenjek district	0	0	0
8	Chandalar district	70,278	52,878	17,400
9	Koyukuk district	378,075	378,075	0
10	Shungnak district	15,000	15,000	0
11	Kiana & Selawik districts	40,607	40,607	0
12	Fairhaven district (Candle subdistrict)	254,265	254,265	0
13	Fairhaven district (Inmachuk subdistrict)	349,975	349,975	0
14	Serpentine district	4,536	4,536	0
15	Port Clarence district	42,358	42,358	0
16	Kougarok district	191,712	191,712	0
17	Nome (Cape Nome) district	5,043,465	5,043,465	0
18	Council district	1,047,042	1,020,042	27,000
19	Koyuk district	84,462	84,462	0
20	Hughes district	403,671	403,671	0
21	Kaiyuh district	149,703	5,400	144,303
22	Anvik district	7	7	0
23	Marshall district	124,506	124,506	0
24	Bethel district	42,953	42,953	0
25	Goodnews Bay district	31,202	31,202	0
26	Aniak district	613,407	613,407	0
27	Iditarod district	1,565,226	1,562,296	2,930
28	McGrath district	364,672	133,307	231,365
29	Innoko district	757,219	757,063	156
30	Ruby district	478,023	478,023	0
31	Kantishna district	99,307	91,401	7,906
32	Hot Springs district	604,926	604,926	0
33	Melozitna district	14,630	14,630	0
34	Rampart district	204,845	204,845	0
35	Tolovana district	547,556	547,556	0
36	Yukon Flats district	0	0	0
37	Circle district	1,125,341	1,125,341	0
38	Black district	2	2	0
39	Eagle district	52,166	52,166	0
40	Fortymile district	602,758	602,758	0
41	Chisana district	144,521	78,021	66,500
42	Tok district	288	288	0
43	Goodpaster district	4,050,903	2,051	4,048,852
44	Fairbanks district	16,625,414	8,282,595	8,342,819
45	Bonnifield district	108,983	102,283	6,700
46	Richardson subdistrict of Fairbanks district[b]	121,828	119,528	2,300
47	Delta River district	11,732	11,732	0
48	Chistochina district	186,604	186,604	0
49	Valdez Creek district	533,167	531,586	1,581
50	Yentna district	204,980	204,980	0
51	Redoubt district	105	105	0
52	Bristol Bay Region	1,570	1,570	0
53	Kodiak district (53b)–Alaska Peninsula Region (53a)	112,409	4,809	107,600
54	Homer district	17	17	0
55	Hope & Seward districts	135,252	70,252	65,000
56	Anchorage district[c]	460	460	0
57	Willow Creek district	667,841	58,841	609,000
58	Prince William Sound district	137,802	102	137,700
59	Nelchina district	15,016	15,016	0
60	Nizina district	148,500	148,500	0
61	Yakataga district	18,041	18,041	0
62	Yakutat district[d]	13,200	2,200	11,000
63	Juneau district (partial)	82,540	82,540	0
64	Juneau (64a) & Admiralty (64b) districts	10,601,763	82,390	10,519,373
65	Chichagof district	770,000	0	770,000
66	Petersburg district	15,000	15,000	0
67	Kupreanof district	0	0	0
68	Hyder district	219	219	0
69	Ketchikan district	62,002	4,002	58,000
70	Bering Sea Region	0	0	0
71	Aleutian Islands Region	0	0	0
	Unknown (undistributed)[e]	272,432	269,238	3,194
	TOTAL (refined Troy ounces)	**50,354,283**	**25,173,604**	**25,180,679**
	(1,566 metric tons)			

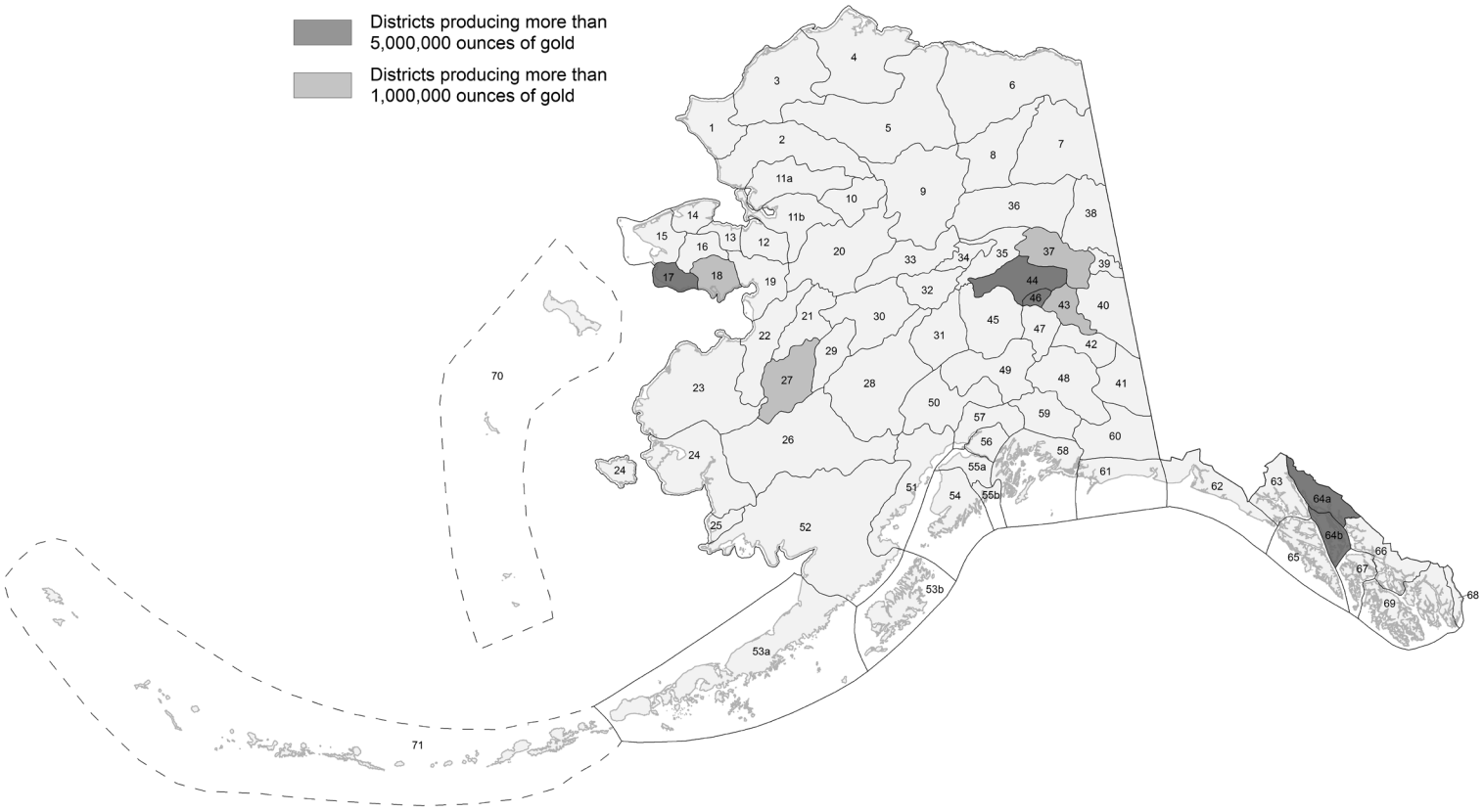
[a]Mining district names and boundaries revised slightly from those defined by Ransome and Kerns (1954) and Cobb (1973). Sources of data: U.S. Geological Survey, U.S. Bureau of Mines, and Alaska Territorial Department of Mines records 1880–1930; U.S. Mint records 1930–1969; State of Alaska production records 1970–2019. Entries of "0" generally mean no specific records are available.

[b]Not included in total for Fairbanks district.

[c]Most placer gold production included in Willow Creek district.

[d]Includes lode production from Glacier Bay area and placer production from Lituya Bay area.

[e]Production that cannot be credited to individual districts due to lack of specific records or for reasons of confidentiality. Beginning in 2015, placer production is not compiled for individual mining districts, but is instead included in the 'Unknown' category.



Back cover, top. (This photo also appears on the front cover). Hy-Tech Drilling USA Inc. drill rig on the Johnson Tract gold and base-metal property in south-central Alaska being explored by HighGold Mining Inc. Mount Iliamna (volcano) is in the background. Photo courtesy of Ian Cunningham-Dunlop, HighGold Mining Inc.

Back cover, bottom. Historical wooden dredge between Nome and Teller, Seward Peninsula. Photo courtesy of Mark Huffington, Kinross Gold Corporation.

State of Alaska
Department of Natural Resources
Division of Geological & Geophysical Surveys