



Special Report 74

ALASKA'S MINERAL INDUSTRY 2018

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



STATE OF ALASKA

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Alaska's Mineral Industry 2018

Jennifer E. Athey¹ and Melanie B. Werdon¹



Above. In 2018 Graphite One completed its fifth season of exploration and fourth season of drilling on their Graphite Creek project on the Seward Peninsula (page 24). Photo courtesy of Stan Foo, Graphite One Inc.

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Cover. High-grade coarse-grained graphite mineralization in drill hole 18GCH021 from 2018 Graphite Creek exploration. Photo courtesy of Stan Foo, Graphite One Inc.

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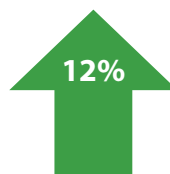
Executive Summary

This summary of the status of Alaska's mineral industry for 2018 is the 38th 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.

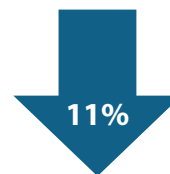
Exploration Expenditures



Development Expenditures



Estimated Revenue to Industry



The reported value of Alaska's mineral industry in 2018 totaled \$2.90 billion, a decrease of 7.7 percent from 2017. The total value for 2018 is a composite of the year's expenditures on exploration and development, plus the revenue to the operators from the commodities produced.

Exploration and development expenditures continued to rebound from the lows of a few years ago, but production and revenues decreased in 2018 for gold, silver, and lead. A sharp drop in the price of silver further impacted revenue for some of Alaska's producing mines.

Zinc continued to be the top metal produced in 2018—accounting for almost 58 percent of Alaska's total metal production by value. Gold followed at almost 28 percent, along with lead at 7.9 percent and silver at 6.6 percent. Production of zinc increased by seven percent in 2018, and its higher revenue nearly offset the decreased revenue of all other metals statewide for that year.

Development expenditures in Alaska rose almost 12 percent in 2018—to \$334.1 million. With the entirety of the Donlin Gold and Pebble projects' budgets assigned in this report to the exploration sector in 2018, development expenditures at Alaska's major metal mines accounted for more than 98 percent of mining development in the State.

Mineral exploration expenditures continued to rise in 2018 to \$140.1 million: a 16 percent increase over 2017. Higher percentages of Alaska exploration dollars were spent on advanced and early-stage projects instead of minesite exploration. Globally, spending on minesite exploration was more significant.

Mining claims and prospecting sites covered more than 3.8 million acres of Alaska in 2018, an almost 29 percent increase over 2017. The total number of 160-acre claims and prospecting sites increased by 49 percent and 33 percent, respectively. The amount of new staking in 2018 decreased, indicating that companies had already established their land positions in 2017.

We estimate mineral industry employment in 2018 at 3,469 full-time-equivalent jobs, an overall increase of about 77 jobs (2 percent) from 2017. The number of exploration jobs continued to increase over 2017 by almost 47 percent to 373 jobs in 2018, a gain of 119 jobs. While the development sector saw a solid increase of 102 jobs, the number of production jobs fell six percent, resulting in a net loss of 42 jobs between the two sectors.

Estimated revenues to the State of Alaska and municipalities from mineral-industry-specific fees, rents, sales, royalties, and taxes amounted to more than \$144.7 million in 2018, an increase of 20 percent from 2017.

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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 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 more than a \$900 million difference between estimated revenue received by operators in 2018 and the theoretical first market value for 2018. When actual revenue values are either not voluntarily reported or must be withheld for reasons of confidentiality, theoretical first market values will be used instead.

In the "Government Revenues from Alaska's Mineral Industry" section, gross income from mining operations as reported on Alaska Mining License Tax returns and explanatory text are also available for comparison with the estimated revenue to industry values from 2015–2017.

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, and Usibelli Coal mines. Several former gold producers are being readied for reopening including the Dawson Mine, Lucky Shot, and Nixon Fork. Promising advanced-exploration and development 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 (figure 1), collectively represent a significant

proportion of United States domestic gold, silver, copper, and base-metal resources: indicating that there are still extremely large mineral deposits to be developed in Alaska. Significant resources of other commodities, including the Graphite Creek graphite deposit and the Bokan Mountain rare-earth-element deposit, promise 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 2018 Alaska was ranked 5th out of 83 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. Alaska also ranked 3rd for mineral potential assuming a “best practices” policy regime.²

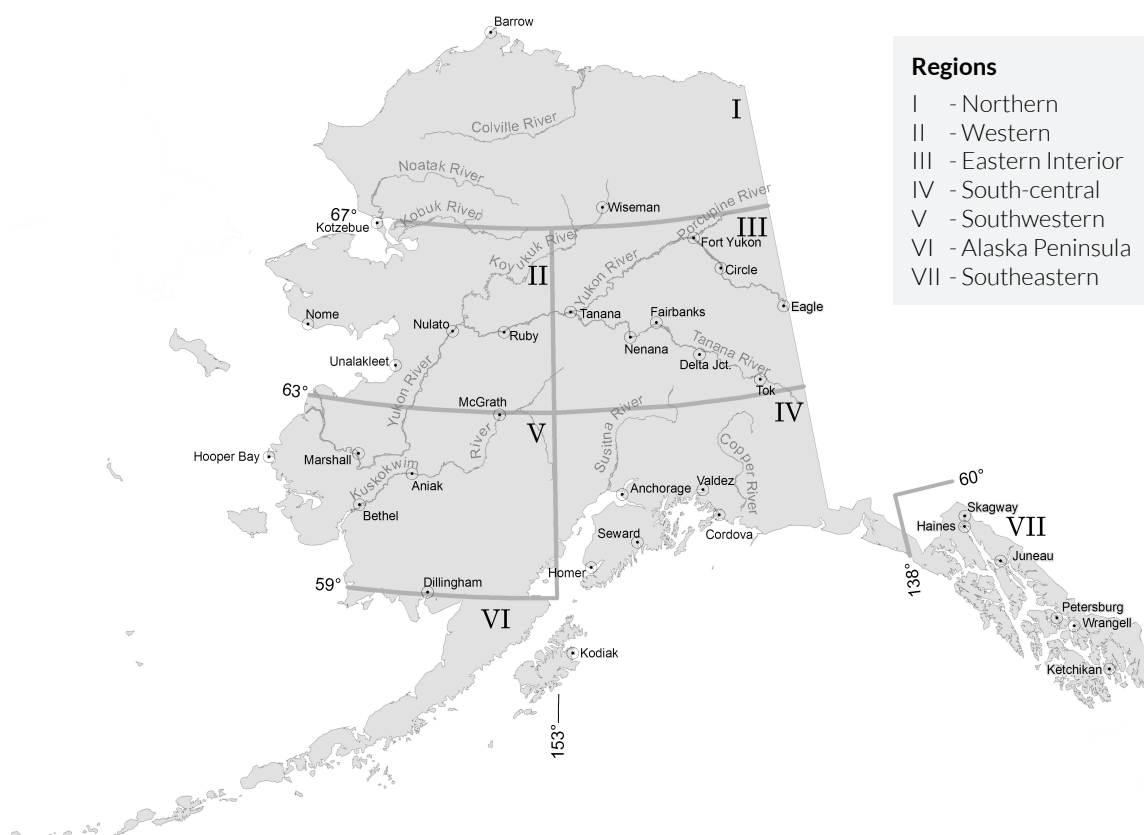


Figure 1. Regions of mineral activity as described in this report.

²Stedman, Ashley, and Green, K.P., 2019, Fraser Institute Annual Survey of Mining Companies, 2018: Fraser Institute, 82 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. 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.

In keeping with rising global exploration budgets, 2018 exploration activity in Alaska jumped another 16 percent to \$140.1 million: almost two and a half times more exploration spending than occurred during the 2015 low (table 1). Development expenditures in Alaska, an indicator of future production, totaled \$334.1 million in 2018: up almost 12 percent from \$299.5 million in 2017. The amount of metal commodities produced and the revenue from their sales showed mixed results in 2018, with zinc production and its revenue higher, but with decreased production of and revenue from all other metals.

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.

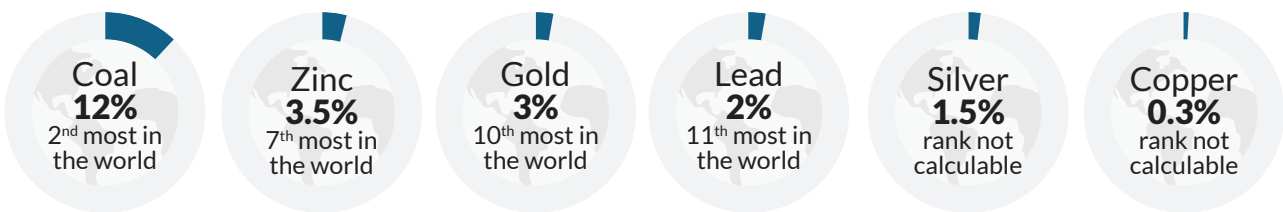


Table 1. Reported annual exploration and development expenditures of the mineral industry, the estimated theoretical first market value of mineral production in Alaska, and estimated revenue to the mineral industry from the sale of those commodities (in millions of dollars), 1981–2018. Average annual values are given for 1981–1985, 1986–1990, 1991–1995, and 1996–2000; individual year totals are provided for 2001–2018.

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

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

^aTheoretical 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 additional charges during its production.

^bEstimated 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 Federal lands (table 11); and gross operating income of placer mining operations from Mining License Tax forms as reported by the Department of Revenue (table 12).

^c2011 and 2015 total missing significant expected data

-- = Not reported

EMPLOYMENT

Employment fluctuations in 2018 closely follow spending in the exploration, development, and production sectors. Total mineral industry employment in 2018 is estimated at 3,469 full-time-equivalent jobs, an overall increase of about 77 jobs (2 percent) from 2017 (table 2). The exploration sector added an estimated 119 jobs, up almost 47 percent from 2017 (photo 1). Exploration employment was estimated for 38 of 63 lode exploration projects using their reported exploration expenditure and (or) drilling footage in conjunction with cost-per-project ratios averaged from 22 and 17 projects with complete employment or drilling data, respectively.

Development gained 102 jobs while production lost 144, a net loss of 42 positions (1 percent). As in 2017, changes in the number of development and production jobs likely reflect new hires for development projects and job reallocation from production to development 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 for 2018 is estimated to be similar to 2017. Yearly change in placer mining employment is unavailable for 2018, 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 2017 was estimated from the number of placer mines that reported gross operating income on Mining License Tax returns: a methodology fully explained in table 12. 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 materials production (rock, sand, and gravel) full-time-equivalent employment increased by 20 percent (40 jobs).³ Reported material-sale volumes increased slightly (3 percent) in 2018. While the industrial materials sector is still 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 2018 employment information. Affidavits of Annual Labor also provided 2018 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 2018 mining employment and wage statistics based on 112 reporting units (companies) consisting of 54 metal ore, 35 coal and nonmetallic-mineral quarrying, and 23 mining-support-activity units. Among companies in 2018, mining and support activities provided 3,110 jobs, up one percent

³Mine Safety and Health Administration, Employment/Production Data Set (dataset 9); last accessed August 26, 2019; <http://web.msha.gov/OpenGovernmentData/OGIMSHA.asp>

from 3,076 jobs in 2017. Mining-support employment grew another 11 percent (23 jobs) over the 36 percent increase in 2017. DLWD data show that nonmetallic-mineral-product manufacturing provided 235 jobs, which includes an average of 231 jobs in cement and concrete manufacturing for 2018. Primary metal manufacturing provided 15 jobs, while metal and mineral merchant wholesalers provided an average of 116 jobs during 2018.

According to DLWD data, 18 boroughs or census areas reported mining (excluding oil and gas) employment in 2018. 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 2018 the Fairbanks area had seven additional businesses paying wages for mining-related work and the highest number of mining jobs (1,198) among Alaska boroughs or census areas, almost level with mining jobs in the area in 2016 (1,209) and negating last year's decline. The Juneau Borough came in second with 842 jobs, up almost three percent from 821 jobs in 2017.

Wages for mining-sector jobs, averaging \$112,857 in 2018, were some of the highest among major industries in Alaska and were more than twice the average private-sector wage of \$54,192 per year. Total wages paid by

Table 2. Estimated Alaska mineral industry employment, 2008–2018^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
Gold/silver mining											
Placer ^c	282	399	405	439	477	432	241	224	222	193	192
Lode	739	832	1,008	1,085	1,206	1,176	1,054	1,047	1,253	1,193	1,132
Polymetallic mining	317	321	350	364	386	390	287	303	306	324	316
Base metals mining	475	413	550	586	530	550	446	475	526	606	482
Recreational mining	30	36	35	41	52	55	7	--	--	--	--
Industrial minerals								173	253	197	237
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
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
Mineral development	516	371	537	422	535	358	468	555	412	536	638
Mineral exploration	546	422	520	535 ^f	548	385	253	116	160	254	373
Total	3,392	3,280	3,872	3,950	4,366	4,051	2,967	2,901	3,232	3,392	3,469

^aReported 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.

^bMSHA data: web.msha.gov/OpenGovernmentData/DataSets/MinesProdYearly.zip

^cSee table 12 for updated information on placer employment calculations.

^dCoal and peat employment numbers are combined in 2009.

^eThis 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.

^fAverage of 520–550 range reported for 2011.

-- = Not reported

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

non-oil-and-gas mining firms in 2018 were \$324,415,686, up five percent from 2017. Total wages paid by mining-support firms in 2018 were \$25,135,503, a 30 percent increase from 2017; total wages paid by mining-support firms have more than doubled since 2016. DLWD employment data is based on wage records, and includes part-time jobs but does 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 2018 Alaska's mining industry provided 4,500 direct mining jobs and an additional 4,700 indirect jobs. Direct



Photo 1. Opportunities for employment in mineral exploration in Alaska continued to rise in 2018. Photo source: Pebble Limited Partnership; last accessed September 21, 2019; pebblepartnership.com/photos.

and indirect wages totaled an estimated \$715 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 60 communities throughout Alaska.⁵

⁴State of Alaska Department of Labor and Workforce Development (DLWD), Research and Analysis Section, Quarterly Census on Employment and Wages (QCEW); last accessed August 27, 2019; live.laborstats.alaska.gov/qcew/ee18.pdf

⁵Alaska Miners Association, The Economic Benefits of Alaska's Mining Industry, March 2019; last accessed August 27, 2019; docs.wixstatic.com/ugd/beae26_a4dc18e6da92420c920f99aa92bbe89b.pdf

GOVERNMENT REVENUES FROM ALASKA'S MINERAL INDUSTRY

Reformatted Mining Tax Analysis

The per-year data in the mining tax analysis by tax bracket (table 4) has been shifted to the prior year to more closely reflect the production year instead of the year in which operators reported tax returns to DOR. For example, the 2017 data reported in last year's Alaska's Mineral Industry 2017, Special Report 73 are now reported as 2016 information in this report; in addition, 2017 (now 2016) data have also been reviewed and updated by DOR to reflect additional tax returns and do not exactly match the values in Special Report 73.

In 2018 government revenue from Alaska's mineral industry totaled \$144.7 million (table 3). The 20 percent increase from \$120.6 million in 2017 is due primarily to increased revenue from the State Corporate Income Tax, which is reported for the State fiscal year (FY 2018: July 1, 2017–June 30, 2018). 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 \$141,731 were received in bond pool payments in 2018. Bond pool payments, which are reclamation financial assurance and not considered State revenue, may only be used to reclaim sites disturbed by mining activities.

Until FY 2018, mining revenues to the State from State Corporate Income Tax (CIT) had largely declined year after year since FY 2013, tracking with metal prices that began sliding in 2012. During much of FY 2018, projected global demand for zinc exceeded projected global supply. The resulting spike in the traded prices of zinc likely positively impacted the profitability of zinc-producing Alaska mines in FY 2018, leading to higher taxes paid by the companies. In addition, the FY 2016 and FY 2017 tax collections numbers for mining CIT included some one-time impacts of prior-year refunds that reduced the net cash collections in those years. Consequently, the increase in FY 2018 likely reflects both an increase in profitability as well as the absence of one-time refunds.

Operators reported total gross income of \$3.070 billion for mineral commodities that sold in FY 2017 (December 1, 2016–November 30, 2017; table 4); this income is compiled from the Mining License Tax returns filed in FY 2018, and is the most recent figure available at the time of this report. Gross income from mining activity that occurred in FY 2018 will be reported in the 2020 edition of this report. Gross income from 2017 differs from the 2017 'estimated revenue to industry' of \$2.7 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 excludes royalty-only taxpayers: royalty-only taxpayers are typically landowners who receive revenue solely from a royalty share with no gross income from mining operations. All six major mines in Alaska earn gross income from mining operations and their income is included in the table's values.

Mining License Tax collections, which continued to rise another 14 percent in 2018, were 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 439 taxpayers submitted Mining

License Tax returns in 2018, of which 50 (11 percent) were liable for taxes on net taxable income from mining in the amount of \$911.2 million, a 47 percent increase over 2017 net taxable income (table 4, production year 2017).

Negative net taxable incomes from mining, at an average loss of \$301,774 per taxpayer, were reported by 144 taxpayers.

Revenue to municipalities decreased in 2018 to \$34.3 million (30 percent decline) over 2017. 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 \$335 million to Native corporations,

and Alaska communities received more than \$2.3 million in charitable donations from the mining industry. Annually, a portion of Alaska's mining industry rents and royalty payments are deposited in the Alaska Permanent Fund.

In 2018, the Permanent Fund earned \$755,234 from the mining industry.

AMA's McDowell report on mining lists other benefits to the State that are not tracked in table 3.⁵ In 2018, the Alaska Railroad Corporation received approximately \$15.9 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.

**In 2018, the
Permanent Fund
earned \$755,234
from the mining
industry.**

Table 3. Reported and estimated revenues paid to the State of Alaska and municipalities by Alaska's mineral industry, 2013–2018. The figures in this table may change as data are reviewed and updated. See footnotes for reporting sources and dates.

	2013	2014	2015	2016	2017	2018
State mineral rents and royalties^{a,b}						
State claim rentals	7,507,976	6,740,816	6,920,029	7,327,630	7,658,003	7,192,888
Production royalties ^c	9,808,575	7,004,376	4,608,137	2,816,884	3,125,925	2,472,558
Annual labor	542,588	389,807	321,419	331,986	374,244	392,085
Subtotal	\$ 17,859,139	14,134,999	11,849,585	10,476,500	11,158,173	10,057,531
State coal rents and royalties^b						
Rents	324,393	315,398	351,724	347,324	268,866	231,159
Royalties ^c	2,757,444	2,514,532	2,430,267	2,237,777	2,232,394	1,971,999
Bonus	--	38,005	111,000	--	--	100
Subtotal	\$ 3,081,837	2,867,935	2,892,992	2,585,101	2,501,260	2,203,258
State material Sales						
Mental Health	-7,854	115,493	69,163	25,130	24,366	50,558
Division of Land ^b	4,965,386	10,559,857	11,293,545	6,412,271	4,637,844	4,540,134
State Pipeline Coordinator's Office	340,786	105,330	197,644	121,994	288,511	93,359
Subtotal	\$ 5,298,318	10,780,680	11,560,352	6,559,395	4,950,720	4,684,051
State mining miscellaneous fees^b						
Filing fees	3,350	3,350	2,100	9,650	4,825	5,150
Bid Bonus	--	93,767	--	193,963	--	--
Penalty fees	205,453	122,035	43,307	95,677	220,770	91,920
Exploration incentive app filing fee	--	--	--	--	--	--
Surface mine investment interest	5,772	7,802	7,801	19,690	--	--
Surface coal mining app fee	22,800	1,300	21,700	7,218	8,000	7,342
APMA mining fees	32,953	26,511	24,302	21,627	21,302	29,024
Subtotal	\$ 270,329	254,764	99,210	347,826	254,897	133,436
Other Fees						
AIDEA - Facilities use fees ^d	11,986,000	11,986,000	11,356,000	10,709,000	10,014,951	9,081,619
State Fuel Taxes ^e	951,852	Not reported	Not reported	2,066,313	1,338,843	1,411,896
State corporate income tax ^f	26,812,498	15,215,598	17,320,051	1,636,850	-729,670	34,594,545
Mining License Tax ^g	46,787,690	23,457,300	38,665,209	11,137,900	41,525,192	47,298,564
Large Mine Permit Coordination Program Receipts ^h	2,238,589	1,919,659	1,725,021	1,364,952	968,827	928,035
State Total	\$ 115,286,252	80,616,934	95,468,420	46,883,837	71,983,193	110,392,935
Payments to Municipalities ⁱ	29,412,224	18,525,615	21,041,152	22,656,383	48,628,626	34,282,140
Total	\$ 144,698,476	99,142,549	116,509,572	69,540,220	120,611,819	144,675,075

^aIncludes upland lease and offshore lease rentals. Figures are reported by calendar year by the Alaska Department of Natural Resources.

^bFigures are reported by calendar year by the Alaska Department of Natural Resources.

^cReported on a cash basis; payments actually received during the given year.

^dAIDEA 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 Pembroke Resources. AIDEA figures are reported by fiscal year. The Red Dog Mine paid an additional \$19M in principal in 2018 on their loan to AIDEA that is not considered revenue to the State.

^eIn 2013, calculated on Fuel and Oil Expenditures from Mining Licenses Tax Form/ Department of Revenue, assuming Alaska average fuel cost of \$6.09, www.commerce.alaska.gov/web/dora/researchanalysis/fuelpricesurvey.aspx. 2016–2018 values were reported by the major operating mines, less their fuel tax

refund.

^fOnly 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.

^gIn 2012 and later, Mining License Tax was not collected on materials. www.tax.alaska.gov/programs/programs/reports/Annual.aspx?60610&Year=2018

^hThe 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).

ⁱPayments 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 2015–2017, based on Mining License Tax returns. Analysis excludes royalty-only taxpayers—those with positive royalties received but zero gross income from mining operations. Information provided by the Alaska Department of Revenue. The figures in this table will change as data are reviewed and updated. Note yearly values were adjusted from those previously included in this report to align with the production year.

Bracket	Marginal rate	No. of taxpayers	Gross income from mining operations	Net taxable income*	Net income as percentage of gross	Total tax liability	Tax Year 2015			Average gross income	Average taxable income	Average tax liability
Under \$0	0%	200	\$36,750,673	\$ -18,781,044	-51%	\$0			\$183,753	-\$93,905	\$0	
\$0 to \$40,000	0%	291	\$5,145,219	\$1,152,052	22%	\$0			\$17,681	\$3,959	\$0	
\$40,001 to \$100,000	3%, 5%	29	\$2,575,137	\$1,200,557	47%	\$38,387			\$88,798	\$41,399	\$1,324	
Over \$100,000	7%	21	\$463,955,821	\$43,467,136	9%	\$1,843,090			\$220,931,34	\$2,069,864	\$87,766	
Total		541	\$508,426,850	\$27,038,701		\$1881,477						
Tax Year 2016												
Under \$0	0%	167	\$168,593,216	\$ -39,655,643	-24%	\$0			1,009,540	-\$237,459	\$0	
\$0 to \$40,000	0%	261	\$10,416,978	\$1,337,360	13%	\$0			\$39,912	\$5,124	\$0	
\$40,001 to \$100,000	3%, 5%	27	\$4,770,085	\$1,395,157	29%	\$46,826			\$176,670	\$51,672	\$1,734	
Over \$100,000	7%	20	\$2,352,232,870	\$616,738,614	26%	\$41,286,436			\$117,611,643	\$30836,931	\$2,064,322	
Total		475	\$2,536,013,149	\$579,815,488		\$41,333,262						
Tax Year 2017												
Under \$0	0%	144	\$169,615,037	\$ -43,455,469	-26%	\$0			\$1,177,882	-\$301,774	\$0	
\$0 to \$40,000	0%	245	\$9,206,266	\$1,207,899	13%	\$0			\$37,577	\$4,930	\$0	
\$40,001 to \$100,000	3%, 5%	30	\$6,088,029	\$1,744,819	29%	\$59,025			\$202,934	\$58,161	\$1,967	
Over \$100,000	7%	20	\$2,884,970,653	\$909,486,138	32%	\$63,133,696			\$144,248,533	\$45,474,307	\$3,156,685	
Total		439	\$3,069,879,985	\$868,983,387		\$63,192,721						

* Net income taxable under the Mining License Tax

Note: The 3% bracket (income \$40,000 to \$50,000) and the 5% bracket (\$50,000 to \$100,000) are combined for this analysis because of confidentiality issues that would arise if each bracket were reported separately. 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.

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 2018. 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 the Darby pluton area on the eastern Seward Peninsula. Research staff at the Geology, Geophysics, and Geochemistry Science Center in Denver conducted 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. Research staff from Anchorage and Denver also participated in national science planning for the new USGS Earth Mapping Resource Initiative (EarthMRI), and developed Alaska focus areas with rare-earth-element potential for new geological mapping and geophysical data acquisition.

Following the successful GIS-based evaluation of critical mineral potential in Alaska in 2016 (doi.org/10.3133/ofr20161191), research staff in Anchorage and Denver applied the GIS methodology to mapping the potential for lode gold associated with porphyry, reduced intrusion-related, epithermal, and orogenic deposits. 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.

Finally, the Alaska Science Center and DGGS collaborated to release updates to the Alaska Resource Data File (ARDF), which include more recent production and exploration data for numerous active mines and exploration projects across the State. Updated geospatial versions of the database were also released in multiple formats.

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 and 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.

The BLM continued with development of two resource management plans (RMPs) in 2018: the Bering Sea–Western Interior Plan and the Central Yukon Plan. The RMPs will result in decisions concerning how BLM will manage lands into the next decades. Additionally, BLM Alaska continued work on an Environmental Impact Statement (EIS) analyzing a proposed road from the Dalton Highway to the Ambler Mining District.

In 2018, for the first time since ANCSA passed, the Secretary of Interior revoked withdrawals that prevented the selection and conveyance to the State of Alaska of lands in the Goodnews Bay region. The withdrawals also prevented staking of new Federal mining claims. By issuing Public Land Order (PLO) 7874, the Secretary revoked five 1972 PLO's issued under Section 17 (D)(1) of ANCSA. The order opened about 230,000 acres of land, which allowed State of Alaska selections to fall into place. About 34,000 acres of previously withdrawn land are now unencumbered and open to Federal mining claim location.

BLM Alaska started inspecting and assessing legacy claims identified in a 2017 inventory of closed Federal mining claims. The claims had been selected by, but not yet conveyed to, the State of Alaska. The inspection and inventory of any disturbances or property left on the claims allows the BLM and the State to determine

whether the lands should be conveyed—or if clean-up is necessary prior to conveyance. This inventory will continue through 2020.

The BLM managed 57 active mining Plans of Operations and 27 Notice-level operations primarily located along the Dalton Highway Utility Corridor, the Steese Highway to Circle area, and the Fortymile Mining District. Approved mining and exploration activities in these areas are almost all related to placer gold mining. In 2018 BLM worked with miners on Wade Creek in the Fortymile District to reclaim another stretch of the creek on a closed mining claim. BLM continued to gather data related to upland and stream reclamation to better understand what can be expected from various reclamation efforts.

Division of Mining, Land and Water

The Division of Mining, Land and Water (DMLW) manages mineral exploration and

development on over 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 (photos 2 and 3). In 2018, 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.

Advanced exploration permitting activities were conducted at the Arctic project in the Ambler Mining District, Graphite Creek on the Seward Peninsula, Donlin Gold in southwest Alaska, Pebble on the Alaska Peninsula, and the Palmer project near Haines. DMLW manages mineral exploration and placer mining through the Application for Permits to Mine in Alaska (APMA). In 2018 there were 442 new applications or renewals of existing applications, a slight increase from 2017. Of these applications, 289

Photo 2, right. Reclamation at the Hogatza (Hog) River placer mine in the Koyukuk-Hughes Mining District showing the natural growth that has occurred over a few years. Photo courtesy of Aaron Kruse, DMLW.

Photo 3, below. Vegetation growth at the True North Mine northeast of Fairbanks in the last 15 years. Fairbanks Gold Mining last operated the mine in 2004. Photo courtesy of William Groom, DMLW.



“
Contacted
[an Alaska]
State regulator
regarding
a permit
application and
they worked
collaboratively
throughout
the application
process to ensure
that it was
completed in a
timely manner.”

A consulting company²

were for placer mining and exploration, 58 were for hard rock exploration, and 95 were for suction dredging activities.

The State regulates coal mining through the Coal Mining Regulatory program. In addition to ongoing mining and reclamation at the active Usibelli Coal Mine, 2018 saw industry interest in developing high-rank coal south of Point Lay and at Herendeen Bay on the Alaska Peninsula. DMLW also processed an application for coal exploration in the Canyon Creek area south of Skwentna.

The State Abandoned Mine Lands program conducted reclamation at the Hydraulic Pit, an abandoned coal mine near Healy. The site was reclaimed using “geomorphic reclamation,” a technique that attempts to recreate the original landforms and drainage patterns with the primary goal of bringing the area to a more natural condition and also reduce the need for future maintenance. For this work, the DMLW won the 2018 Western Regional Award from the Department of Interior’s Office of Surface Mining for Outstanding Reclamation.



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. 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.

In 2018, the 100,000-square-foot facility at 3651 Penland Parkway in Anchorage became half-full (photo 4). The new facility features comfortable viewing areas with roller tables and high-lumen overhead lighting. The sample preparation room contains 14" and 20" slabbing saws. The GMC tracks just under 718,000 samples, including 38,732 core boxes from 276 prospects representing 2,252 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 2018 included Solitario Zinc’s ten pallets of core, comprising 488 boxes from ten historical core holes drilled at the Lik deposit of the De Long Mountains (photo 5).



Alaska continues to catalog and provide useful geologic information about the region.”

A producer company²

Photo 4. Cores and samples stored at the GMC hold extreme value, as there is often need to revisit previous work as science progresses. The information these materials provide may help the discovery of new mineral deposits.

Photo 5.

Solitario Zinc Corp. donated ten previously drilled core holes from their Lik zinc–lead–silver sediment-hosted massive sulfide deposit northwest of Red Dog mine to the GMC.

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 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 (figure 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 (table 6) or the State of Alaska capital budget.

Geophysical Datasets

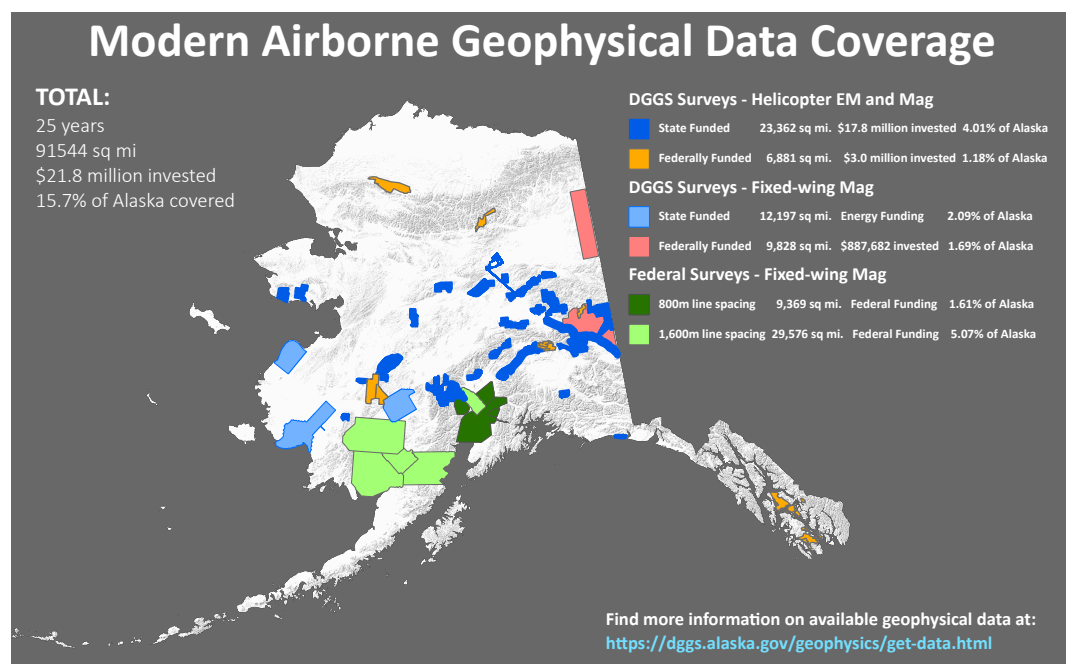
In 2018 no new geophysical data were collected by DGGs. Goldstream and Yukon Crossing engineering-geology-support surveys were published in 2018. DGGs continues to archive and reformat prior surveys and make those data accessible online. DGGs has received EarthMRI funding from the USGS, and plans to collect new magnetic and radiometric data in the Yukon Tanana Uplands in calendar year 2020.

Geologic Mapping and Geochemical Sampling

In 2017 and 2018, Mineral Resources geologists completed a 520-square-mile, detailed

Table 5.
New mineral resource-related DGGs publications in 2018.

Geologic maps, reports, and geochemical data	
Northeastern Tanacross area (presentation) –	doi.org/10.14509/30123
Northeastern Tanacross area geochemical data –	doi.org/10.14509/30113
Northeastern Tanacross area Ar/Ar data –	doi.org/10.14509/30112
Richardson district geochemical data –	doi.org/10.14509/30119
Tok River gold prospects (presentation) –	doi.org/10.14509/30030
Alaska's mineral industry 2017 (report) –	doi.org/10.14509/30075
Alaska's mineral industry 2017 (presentation) –	doi.org/10.14509/29851
Arsenic in Interior Alaska groundwater –	doi.org/10.14509/30094
Arsenic in Alaska groundwater –	doi.org/10.14509/30060

**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 25 years. Survey data are available from the Division's website: maps.dggs.alaska.gov/gp/.

Survey Area	Survey Size (square miles) ^b	Resulting Products
Wrangell/Stikine ^c	1,117	Airborne geophysical survey
Koyukuk/Wiseman	551	Airborne geophysical survey
Ketchikan ^d	848	Airborne geophysical survey
Aniak	1,270	Airborne geophysical survey
Delta River	642	Airborne geophysical survey
Sleetmute	675	Airborne geophysical survey
Howard Pass–Misheguk Mountain	1,529	Airborne geophysical survey
Western Fortymile	250	Airborne geophysical survey
Tanacross ^e	4,536	Airborne geophysical survey
Porcupine ^e	5,292	Airborne geophysical survey
Total \$3.9 million	16,710	2.87% of Alaska's total area

Table 6.

DGGS-managed, Federally funded detailed airborne geophysical survey work as of December 2018.^a

^aProjects funded mainly by U.S. Bureau of Land Management with contributions from DGGS, local and State governments, and private corporations. Projects concentrate mainly on Federal land. Data are released through DGGS.

^b In 2018 DGGS standardized the calculation of the data collection footprint to better represent the actual footprint of data collection.

^c Major funding provided by BLM and the City of Wrangell.

^d Major funding provided by BLM and Ketchikan Gateway Borough. Sealaska Corp., Alaska State Mental Health Land Trust Office, the City of Coffman Cove, and the City of Thorne Bay also contributed funds. Sealaska Corp. also contributed previously acquired geophysical data.

^e Funding provided by U.S. Geological Survey.

geologic mapping and geochemical sampling project in northeastern Tanacross quadrangle adjacent to Yukon, Canada (photo 6). The purpose of this project is to evaluate the area's mineral-resource potential and to create a geologic map to help guide industry exploration efforts. The area contains known porphyry gold–copper–molybdenum systems, such as Taurus, which are newly recognized to be spatially associated with high-angle fault systems, many of which can be identified in DGGs airborne geophysical surveys of the area.

Mineral Resources geologists also completed fieldwork for the second phase of a 430-square-mile geologic mapping and geochemical sampling project in the Richardson–Uncle Sam gold

exploration area northwest of Delta Junction. The purpose of this project is to integrate geological, geophysical, and mineral industry datasets to create an improved geologic map that will guide exploration and help determine the area's mineral-resource potential, which is expected to be high based on known prospects, placer mines, and proximity to the Pogo gold mine.



Photo 6.
DGGs geologist
Alicja Wypych
collects samples
during the 2018
field season in the
Tanacross area of
interior Alaska.
Photo courtesy
of Evan Twelker,
DGGs.

EXPLORATION

Alaska exploration spending continued to increase in 2018 to \$140.1 million (16 percent growth; figures 3 and 4), almost keeping pace with the nearly 19 percent growth in global exploration expenditures. Alaska's share of the \$10.1 billion global exploration budget was again 1.4 percent.⁶ The exploration sector's recovery, which began in 2016, continued in 2018 with upward momentum despite weaker financing mid-year and rocky metal prices. Alaska exploration spending by commodity and deposit type generally followed global trends, with funding for gold projects making up 50 percent of budgets globally and 49 percent statewide (table 7; figure 5). Copper targets garnered 22 percent of the global exploration budget and 20 percent statewide. However, Alaska exploration spending for base metals outstripped global base-metal exploration spending by 26 percentage points.

Sixty-three mineral exploration projects, some managed by the same company, reported activity in 2018. Minesite exploration dropped to 20 percent—a 31 percent decrease from 2017—possibly due in part to the major mines' reluctance to fund exploration from decreased revenues; some also are exploring for new resources farther afield than their immediate minesites. Ten advanced-exploration projects and projects in the permitting stage spent 43 percent of the exploration budget, as compared to 39 percent of global exploration expenditures going to late-stage projects.⁶ Forty-nine early-stage exploration projects spent 36 percent

(\$28.5 million) of Alaska's exploration budget, while globally, 35 percent of funding went to greenfields exploration.⁶ Excluding the operating mines, 20 projects spent \$1 million or more, up from 17 projects in 2017. An additional 17 projects each spent \$100,000 or more.

In 2018, the Fraser Institute assessed factors related to permitting that affect exploration decisions in Canada, the U.S., Australia, and Scandinavia.² In the United States in 2018, Alaska had the highest number of mining exploration company respondents who indicated they received their exploration permits in two months or less. Alaska also led the states in issuing exploration permits according to established timelines and meeting guidelines 80 to 100 percent of the time. No respondents indicated that the level of process transparency deterred investment.

The total area of the State covered by mining claims and prospecting sites in 2018 increased by almost 29 percent to over 3.8 million acres (table 8). The total inventory of 160-acre claims and state prospecting sites increased by 49 percent and 33 percent, respectively, while the total number of valid 40-acre claims decreased. Although the total acreage increased, fewer new claims and prospecting sites were staked in 2018 compared to 2017.

Northern Region Anarraq-Aktigiruaq

Teck Alaska Inc. continued to explore for sediment-hosted massive sulfides at their

**Alaska was one
of the highest
performers in all of
the jurisdictions in
the effectiveness
of its permit
approval process.**

⁶S&P Global Market Intelligence, 2019, World Exploration Trends: A special report from S&P Global Market Intelligence for the PDAC International Convention, 12 p. www.spglobal.com/marketintelligence/en/documents/world-exploration-trends-march-2019.pdf

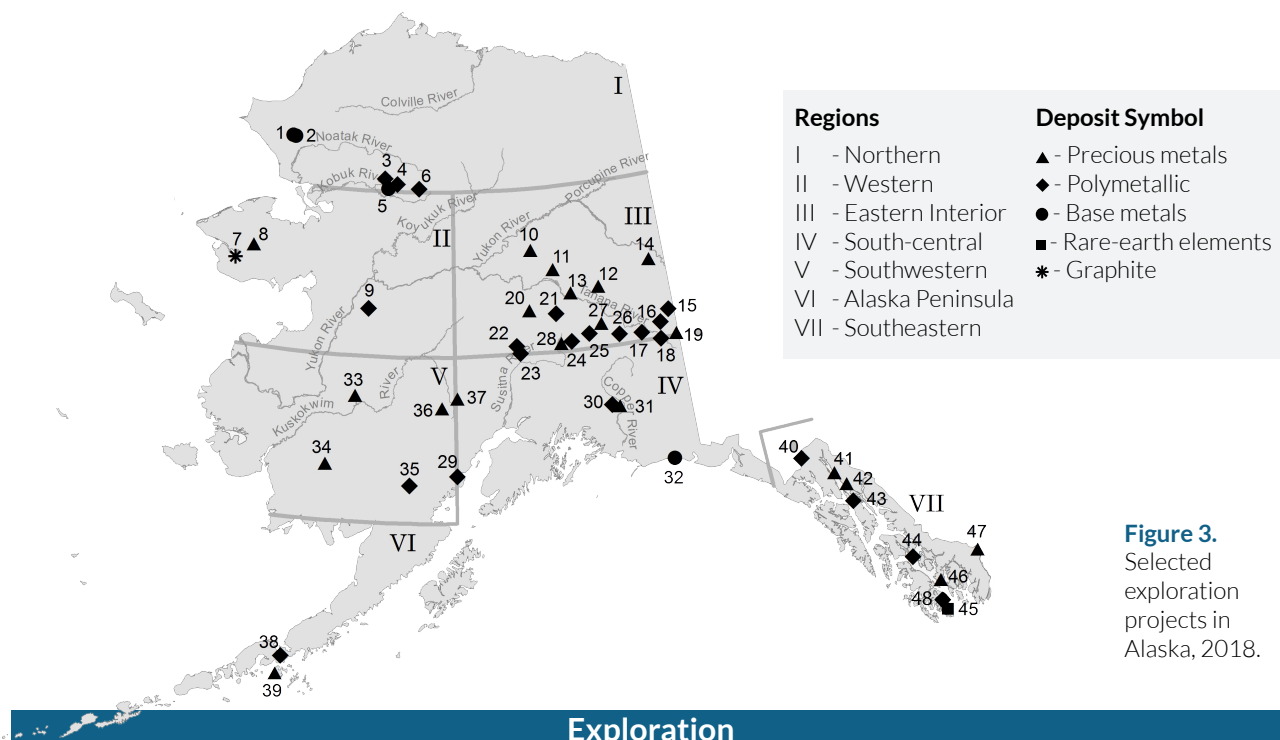


Figure 3.
Selected
exploration
projects in
Alaska, 2018.

Exploration

I. Northern Region

1. Lik–Solitario Zinc Corp. / Teck
2. Anjarraaq-Aktigirug –Teck
3. Smucker–Teck
4. Arctic–Trilogy Metals Inc.
5. Bornite–Trilogy Metals Inc.
6. Sun–Valhalla Metals Inc.

II. Western Region

7. Graphite Creek–Graphite One Resources
8. Kougarok and Lost River–Greatland Exploration Ltd.
9. Round Top–Western Alaska Copper & Gold

III. Eastern Interior Region

10. Tolovana District
 - a. Livengood–International Tower Hill Mines Ltd.
 - b. Shorty Creek–Freegold Ventures Ltd.
 - c. Elephant Mountain–Endurance Gold Corporation
 - d. McCord–Endurance Gold Corporation
11. Fairbanks District
 - a. Fort Knox and district–Kinross Gold Corp.
 - b. Golden Summit–Freegold Ventures Ltd.
 - c. Treasure Creek–Treasure Creek Partnership
12. Goodpaster District
 - a. Pogo mine area–Northern Star
 - b. West Pogo–Millrock Resources Inc.

- c. Tibbs–Tectonic Resources LLC
- d. Healy Claims–Northway Resources Corp.
13. Richardson Subdistrict
 - a. Richardson–Coeur Mining Inc.
 - b. Tower–Tower Exploration LLC
 - c. Uncle Sam–GAME
14. Seventymile–Tectonic Metals Inc.
15. Tanacross Project–Kenorland Minerals
16. Oreo–Tubutulik Mining Company LLC
17. Peak–Peak Gold LLC
18. Northway–Tectonic Metals Inc.
19. McArthur Creek–K2 Gold Corp.
20. Liberty Bell–Millrock Resources Inc.
21. Red Mountain–White Rock Minerals Ltd.
22. Golden Zone–Avidian Gold Inc.
23. Honolulu–Honolulu Prospect Corp.
24. Alaska Range Project–PolarX Ltd.
25. Emerick, Tres Equis–Northridge Exploration
26. Delta VMS–Agnico Eagle Mines Ltd.
27. Hajdukovich–Valhalla Metals Inc.
28. Valdez Creek Lode–Valdez Creek Mining LLC

IV. South-central Region

29. Johnson Tract–Constantine Metal Resources Ltd.
30. Genesis–Anglo Alaska Gold Corp. and New Age Metals Inc.
31. Opal–Ben Porterfield

32. Icy Cape–Alaska Mental Health Trust Land Office

V. Southwestern Region

33. Donlin Gold project–Donlin Gold LLC
34. Luna–Quicksilver–Kisa–Riversgold Ltd.
35. Pebble–The Pebble Limited Partnership
36. Terra–West Mountain Gold
37. Estelle and Farewell Projects–Nova Minerals Ltd.

VI. Alaska Peninsula Region

38. Pyramid/San Diego Bay–CopperBank Resources Corp.
39. Unga–Redstar Gold Corp.

VII. Southeastern Region

40. Palmer–Constantine Metal Resources Ltd.
41. Kensington/Jualin–Coeur Alaska Inc.
42. Herbert Gold–Grand Portage Resources Ltd.
43. Greens Creek Mine–Hecla Mining Company
44. Zarembo Island–Zarembo Minerals Co. LLC
45. Bokan Mountain–Ucore Rare Metals Inc.
46. Helm Bay–Agnico Eagle (USA) Ltd.
47. Crest–Decade Resources Ltd.
48. Niblack–Heatherdale Resources Ltd.

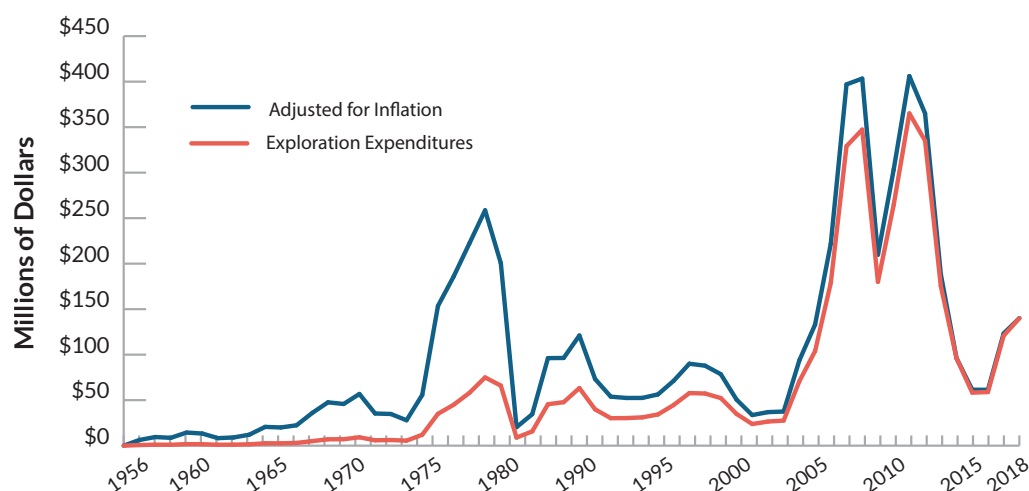


Figure 4. Alaska mineral exploration expenditures, 1956–2018. Blue line is adjusted for inflation to 2018 dollars.

Aṅarraaq and Aktigiruk deposits, about eight miles northwest of Red Dog mine. Ongoing investments in second-generation structural and stratigraphic mapping, deep-penetrating airborne time-domain electromagnetic surveying, and footprint geochemistry have refined and improved Teck's integrated targeting models. Teck's Aṅarraaq deposit is an elongate, lens-shaped massive sulfide body that is 3,280 feet long, 1,640 feet wide, and up to 262 feet thick, with an inferred resource of 21,428,906 tons grading 14.4 percent zinc, 4.2 percent lead, and 2.13 ounces of silver per ton (appendix D).

In their annual report, Teck stated that they completed approximately 32,800 feet of drilling in 2018. Their drill program tested the internal continuity and lateral extents of the Aktigiruk deposit, where mineralization is located at depths of between 1,312 and 3,280 feet below surface. Prior-year drill-hole highlights include: DDH1737 with 177 feet grading 16.8 percent zinc, 3.63 percent lead, and 0.048 ounce of silver per ton; and DDH1745 with 44.6 feet grading 19.68 percent zinc, 5.54 percent lead, and 0.112 ounce of silver per ton. Mineralization remains open in several

directions. As of February 2017, 29 drill holes had been completed at a nominal 1,148- by 1,148-foot drill spacing. Although this spacing is not yet sufficient to estimate an official mineral resource, Teck stated that their drill data suggest an exploration target for Aktigiruk in the range of 80–150 million tons of mineralization at a grade of 16–18 percent combined zinc plus lead (photo 7).

Lik

Solitario Zinc Corp. and 50/50 owner Teck Resources restarted exploration at their Lik zinc–lead–silver sediment-hosted massive sulfide deposit northwest of Red Dog mine. Lik hosts two massive sulfide deposits separated by a fault. Lik has 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 companies' 2018 exploration program consisted of geologic mapping and geochemical sampling over the deposit and potential extensions to the northeast; a ground gravity survey over prospective stratigraphy, mainly on the eastern half of the property; a seismic survey; and recovery of 19 previously drilled core holes.

If continued drilling confirms this, Aktigiruk 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.

Table 7. Reported exploration expenditures in Alaska by commodity, 1981–2018. Exploration expenditures were estimated for nine projects using their reported work. Exploration expenditures were estimated for two additional projects using their reported drilling footage, and a project-cost ratio averaged from 17 projects, with reported, complete data.

	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
Total	\$ 298,109,326	\$ 1,369,256,659	\$ 1,882,591,604	\$ 15,650,833	\$ 39,117,950	\$ 78,840,379	\$ 3,683,566,751

^aPolymetallic deposits considered a separate category for the first time in 1992.

^bApproximately \$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.

^cIncludes rare-earth elements, magnetite sands, and graphite.

N/A = Not available

-- = Not reported

W = Withheld; data included in "Other" column

2018 Exploration Expenditures by Deposit Type

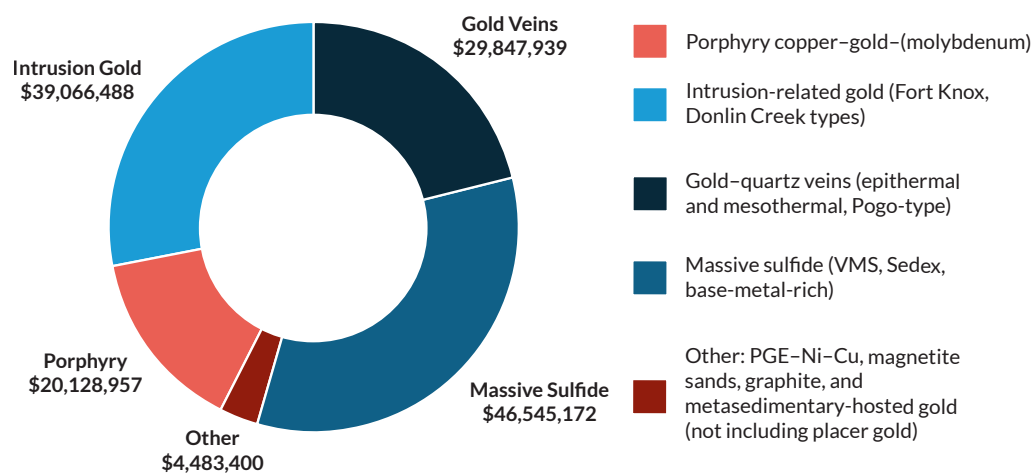


Figure 5. Exploration expenditures by deposit type, 2018.

Ambler Mining District Bornite and Arctic

Trilogy Metals Inc. signed an agreement with South32 Limited in April 2017 granting South32 an option to form a 50/50 joint venture on Trilogy's Upper Kobuk Mineral Projects (UKMP), which includes the Arctic and Bornite deposits, the exploration and option-to-lease agreement with NANA Regional Corporation, Inc., and the remainder of Trilogy's state mining claims along the 62-mile-long VMS belt in the Ambler Mining District. South32 must contribute a minimum of \$10 million each year starting in 2017, for a maximum of three years, to keep the option in good standing. South32 may exercise its option at any time to form the 50/50 joint venture partnership. To subscribe for 50 percent of the joint venture, South32 will contribute a minimum of \$150 million, plus any amounts Trilogy spends at Arctic over the next three years to a maximum of \$5 million per year, less the initial funding contributed by South32. As of year-end 2018, South32 has contributed \$20.8 million to the UKMP.

In 2017 the Alaska Industrial Development and Export Authority (AIDEA) submitted an application requesting the issuance of right-of-way grants, permits for constructing bridges, and related authorizations associated with the proposed construction and operation of an approximately

211-mile-long, all-season industrial road to provide access to the Ambler Mining District. On April 30, 2018, the BLM released the Ambler Road EIS Scoping Summary report. The road's permitting process, under the National Environmental Policy Act's (NEPA) requirements, has now concluded the scoping phase and has moved to the Draft EIS phase. To date, the project is on schedule: the completed final EIS is expected by December 31, 2019, and the Record of Decision is anticipated shortly thereafter.

Bornite

South32 Limited funded a \$10.8 million exploration program at Trilogy Metals Inc.'s Bornite carbonate-hosted copper-replacement deposit in the southern Brooks Range. Trilogy released a maiden cobalt resource for Bornite in June 2018; currently the deposit has an indicated and inferred resource of more than 200 million tons at 1.58 percent copper for greater than 6.3 billion pounds of copper, and 0.02 percent cobalt for 77,000,000 pounds contained cobalt (appendix D).

Trilogy's 2018 Bornite program included drilling, metallurgical studies, and a seismic survey. Mineralization occurs as a series of "reefs" hosted by both the Upper and Lower Bornite Carbonate sequences separated by a generally unmineralized phyllite unit. The copper-cobalt mineralization at Bornite occurs in three distinct

Table 8. Summary of claim activity, 1991–2018. Reported claim numbers may be considered a best approximation, because: (1) pending actions (new entries or abandoned claims), adjustments, and corrections may change claim numbers after publication of this report; and (2) occasional changes in reporting (recent changes described in the footnotes) may make values not directly comparable with values from the previous year. This dataset may be used to identify general trends in claim staking, but detailed information about case actions and claims should be accessed through DNR’s Land Administration System.

Year ^a	State Claims				State Prospecting Sites (160 acres)		Federal Claims (20 acre sites)	
	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

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.

^aIn 2011, 2013, and 2017, the methodology of calculating State claims and prospecting sites changed and values 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 90 active 40-acre claims and 54 active 160-acre claims on State-selected land in 2018, as compared with 61 active 40-acre claims and 202 active 160-acre claims on State-selected land in 2017.

^bIncludes claim fractions varying from 1 to 39 acres.

-- = Not reported

**Photo 7.**

Results from Teck Alaska Inc.'s regional exploration for sediment-hosted massive sulfides may keep the mill at the Red Dog mine (foreground) in northern Alaska busy for many years in the future. Photo courtesy of William Groom, DMLW.

carbonate zones: the Upper Reef, the Lower Reef, and the South Reef. All three zones were tested with 12 infill and offset diamond drill holes totaling 33,212 feet. Drill hole RC18-0247 tested extensions of high-grade copper mineralization at depth along the South Reef trend. At a cut-off grade of 1.5 percent copper, RC18-0247 contains an interval of 53.8 feet grading 5.34 percent copper and 0.21 percent cobalt. Additionally, a 7-line-mile 2D seismic survey was conducted; the survey was designed to track massive sulfide zones as well as basement and other structures to assist with exploration targeting.

Trilogy's metallurgical test work on samples from two drill cores from the Bornite in-pit resource area demonstrated that a high-quality, 24–33 percent copper concentrate containing no deleterious metals can be produced. Copper minerals display a wide variety of grain sizes. The majority are well liberated at 100 microns; however, a minor fraction of the contained copper is present as very fine-grained copper-sulfide minerals occurring in pyrite (5 to 15 percent of the overall copper). Additionally, grindability test work indicates an average Bond Work Index of 8.9 kilowatt-hours per ton, which is considered soft and indicates future low grinding costs and power consumption. Initial metallurgical and

geometallurgical work on in-pit and below-pit samples showed that cobalt is found primarily within cobaltiferous pyrite, cobaltite, and carrollite. Greater than 80 percent of the cobalt is found in pyrite, which preferentially reports to the copper tails.

Arctic

Trilogy Metals Inc.'s approximately \$6.7 million program for their Arctic VMS project in the southern Brooks Range consisted of approximately 1,946 feet of geotechnical and hydrological drilling. The geotechnical program consisted of 24 large-diameter drill holes and 40 excavated test pits, and was designed to provide additional geotechnical and hydrologic information for the waste rock dump, tailings management facility, and surface infrastructure. In addition, studies on the Arctic road alignment (from the Arctic mine site to Dahl Creek), acid rock drainage and metal leaching potential, ore-sorting capabilities, and metallurgical studies at Arctic were started during 2018. Trilogy also completed their ore-sorting program initiated in 2017. Early indications are that the application of this technology could improve the head grades of material being processed at the proposed Arctic grinding mill by eliminating waste rock.

In February 2018, Trilogy released a pre-feasibility study for Arctic. Highlights include

- A pre-tax Net Present Value (NPV8%) of \$1,935.2 million calculated at the beginning of the three-year construction period and an Internal Rate of Return (“IRR”) of 38.0 percent for the base case;
- An after-tax NPV8% of \$1,412.7 million and after-tax IRR of 33.4 percent for the base case;
- An initial capital expenditure of \$779.6 million and sustaining capital of \$65.9 million for total estimated capital expenditures of \$845.5 million over the estimated 12-year mine life;
- Closure and reclamation costs are estimated at \$65.3 million;
- An estimated pre-tax and after-tax payback of initial capital within two years (at \$2.00/pound copper) and after-tax payback in three years;
- A minimum 12-year mine life supporting a maximum 11,000 ton-per-day conventional grinding mill-and-flotation circuit to produce copper, zinc, and lead concentrates containing significant gold and silver by-products;
- A life-of-mine strip ratio of 6.9 to 1;
- An average annual payable production projected to be more than 159 million pounds of copper, 199 million pounds of zinc, 33 million pounds of lead, 30,600 ounces of gold, and 3.3 million ounces of silver;
- A capital intensity ratio on initial capital of approximately \$6,834 per ton of average annual copper equivalent produced;
- Estimated cash costs of \$0.15/pound of payable copper; and
- Total “all-in” cash costs (initial/sustaining capital, operating, transportation, treatment and refining charges, road toll, and by-product metal credits) estimated at \$0.63/pound of payable copper.

Sun

Valhalla Metals Inc. acquired 230 mining claims covering 36,000 acres in the eastern Ambler Mining District in 2018. Their Sun

property includes the Sun VMS deposit and a number of other prospects. The Sun deposit was first discovered in 1974 by Sunshine Mining Co. In total, 97 drill holes totaling 62,740 feet have been completed on the Sun property. Andover Mining Corp. completed 48 holes during 2007, 2011, and 2012, in addition to the 49 drill holes completed previously by Anaconda, Noranda, Cominco, and Bear Creek Mining Company. Sun has indicated and inferred resources of 15.2 million tons grading 1.18 percent copper, 1.32 percent lead, 3.94 percent zinc, 0.007 ounce of gold per ton, and 2.15 ounces of silver per ton (appendix D). Although no exploration was conducted in 2018, Valhalla completed a technical report for the property.

Smucker

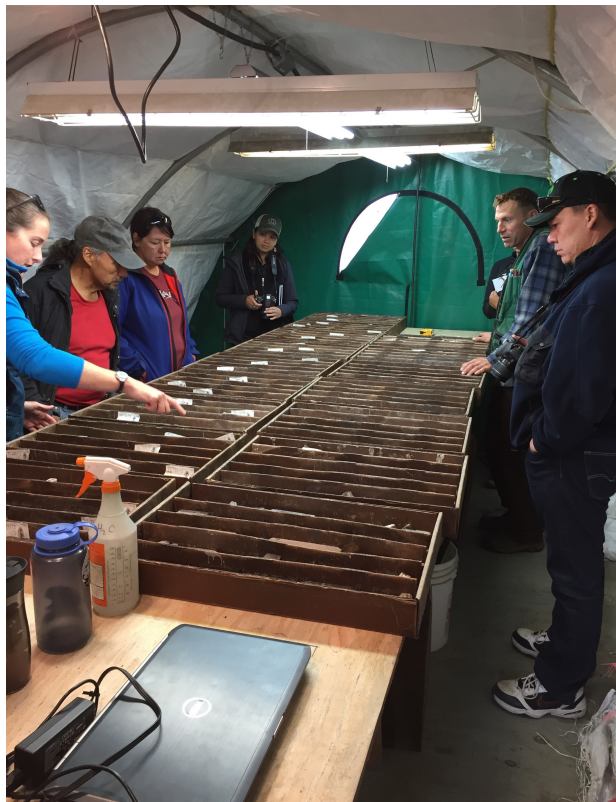
Teck American Inc. conducted geologic mapping and rock sampling on their Smucker claim block in 2018. The property includes the Smucker VMS deposit, which is the westernmost known VMS deposit in the Ambler mineral belt of the southern Brooks Range. The deposit contains a historical inferred resource estimate of 12.8 million tons grading 0.95 percent copper, 2.3 percent lead, 6.4 percent zinc, 0.025 ounce of gold per ton, and 4.78 ounces of silver per ton (appendix D).

Western Region Graphite Creek

Graphite Creek, the United States’ largest large-flake graphite deposit, is located 34 miles north of Nome on the Seward Peninsula. Owned by Graphite One Inc., Graphite Creek is an advanced-exploration-stage project progressing towards the evaluation phase. In 2017 Graphite One released their inaugural preliminary economic assessment (PEA) for development of a graphite manufacturing project for Graphite Creek. In the PEA, the project is initially conceived as a vertically integrated manufacturer of high-grade coated spherical graphite (CSG), with mining and processing facilities near Nome, Alaska, and advanced material processing taking place at a dedicated graphite product

manufacturing facility, possibly in Washington State. A minimum of 40 years of indicated and inferred resources grading seven percent carbon as graphite (Cg) have been identified to sustain full-scale operations. Approximately 1,122,000 tons of graphite-bearing material are projected to be mined per year, with extraction and recovery of 66,000 tons per year of concentrate grading 95 percent Cg. The concentrate would be transported overland to the port of Nome and shipped by barge to a product-manufacturing plant, where it would undergo thermal purification, mechanical-chemical processing (spheronization), classification, coating of spherical graphite, and heat treatment. The envisioned manufacturing plant would deliver 46,132 tons of high-grade coated spherical graphite per year for lithium-ion battery applications along with 14,881 tons of refined, sub-20-micron graphite powder per year for various end-uses.

In 2018 Graphite One completed its fifth season of exploration and fourth season of drilling on their Graphite Creek project, including infill drilling of 2,628 feet of HQ core in six holes.



Highlights include 27.9 feet grading 10.81 percent Cg in hole 18GS022; 15.1 feet grading 12.27 percent Cg in hole 18GS023; and 53.5 feet grading 11.93 percent Cg in hole 18GS026. High-grade graphite mineralization is present at the surface and has been extended to depths of over 656 feet by drilling. The deposit remains open along strike to the east and west, as well as down dip. Airborne resistivity data suggest additional potential for resources on the broader Graphite Creek property. Current resources for the Graphite Creek deposit are tabulated in appendix D. Graphite One also conducted field-engineering studies and lidar surveys to evaluate alternatives for connecting the project to the existing state-maintained road system. In addition, they undertook environmental studies, and provided tours and project updates to neighboring communities (photo 8).

Round Top

Western Alaska Copper & Gold conducted its third year of exploration drilling in 2018 at the Round Top property near the past-producing Illinois Creek mine in western Alaska, 55 miles south of Galena. Round Top is a combined copper-silver-molybdenum porphyry, skarn, and lead-zinc-silver carbonate-replacement deposit. Western Alaska drilled 12 holes for a total of 14,540 feet. The drilling program tested high-grade primary copper-silver mineralization discovered in drill hole RT-17-19 in 2017, expanded the known chalcocite footprint at East Lobe, and tested multiple step-out targets at West Lobe and the TG North lead-zinc-silver carbonate-replacement prospect. Western Alaska discovered a new molybdenum-enriched intrusion in drill holes RT-18-23 and RT-18-24.

In the general East Lobe area, drill hole RT-18-22 re-entered hole RT-17-22 and successfully reached primary chalcopyrite-magnetite mineralization. An upper 132.8-foot interval

Photo 8. Graphite One provided updates on their Graphite Creek project on the Seward Peninsula at meetings in neighboring communities and hosted project tours and meetings for a Subsistence Advisory Council comprised of representatives from the three Alaska Native villages closest to the project. Photo courtesy of Stan Foo, Graphite One Inc.

averaged 0.27 percent copper-equivalent (Cu Eq). A lower 104-foot interval averaged 0.43 percent Cu Eq, with strong silver and molybdenum credits. The last sample in RT-18-22 at 1,524.9 feet returned 0.87 percent copper, 0.007 percent molybdenum, and 2.69 ounces of silver per ton. Drill hole RT-18-23 intersected approximately 984 feet of copper mineralization in three separate zones and encountered an early molybdenum phase of mineralization. The most significant intercept was 688 feet of 0.28 percent Cu Eq. One 122.7-foot interval from 1,781.8 feet to 1,904.5 feet averages 0.53 percent copper, 0.15 ounce of silver per ton, and 0.021 percent molybdenum (Cu Eq of 0.63 percent). Drill hole RT-18-32 intersected a 210-foot intercept of chalcocite enrichment, which averaged 0.68 percent copper and 0.24 ounce of silver per ton (photo 9). Another 76.1-foot interval contains 0.27 percent copper and 0.14 ounce of silver per ton. Exploratory drill hole RT-18-33 tested a magnetic high feature in 3D magnetic models; it intersected a new copper-mineralized intrusion with a 199.8-foot intercept of 0.30 percent Cu Eq. Drill hole RT-18-25 intercepted a 69.9-foot interval that averaged 0.72 percent Cu Eq.

Two exploratory drill holes in the West Lobe area targeted copper–silver anomalies. Drill hole RT-18-27 intersected 98 feet of 0.32 percent Cu Eq with pyrrhotite and chalcopyrite in an intensely altered and brecciated zone. Drill hole RT-18-28 encountered similar alteration and brecciation. Additionally, drill hole RT-18-29 explored the

northern portion of the TG North lead–zinc–silver carbonate-replacement target about two miles northwest of the Round Top East Lobe drilling area. RT-18-29 cut a zone that averaged 1.6 percent lead and almost two ounces of silver per ton over a thickness of nearly 20 feet.

In September 2018, Western Alaska Copper & Gold and Piek Incorporated formed the Illinois Creek Joint Venture, which includes the historical Illinois Creek mine with a drill-indicated oxide-gold resource of approximately 424,000 gold-equivalent ounces, and a drill-indicated high-grade lead–zinc–silver resource at the Waterpump Creek deposit.

Kougarok and Lost River

Greatland Exploration Ltd. holds the Late Cretaceous intrusion-related, critical-minerals-bearing, Kougarok niobium–tin–tantalum (lithium) deposit, with a historical non-NI 43-101-compliant resource of 240,000 tons of material grading 1.3 percent tin (based on 0.1 percent cut-off grade, 9 drill holes, and 2 trenches), and the historical Lost River tin (beryllium–lithium–fluorite–tungsten) mine on the Seward Peninsula. Greatland is reevaluating zinnwaldite-bearing granites at both properties for their lithium potential. In 2018 Greatland obtained multi-element analyses on 440 samples from Anaconda Minerals Company's historical drill cores at Kougarok.

Eastern Interior Fairbanks District Fort Knox

Kinross Gold Corporation continued to explore for proximal extensions of its Fort Knox orebody about 20 miles north of Fairbanks and at surrounding greenfields properties. A total of 36,089 feet of drilling was completed in 37 holes during 2018 within and adjacent to the open pit. At the East Wall exploration area on the eastern side of the open pit, drilling of 20 holes showed



Photo 9. High-grade chalcopyrite mineralization from East Lobe drill hole RT-18-32 at the Round Top property in western Alaska. Photo courtesy of Kit Marrs, Western Alaska Copper & Gold.

upside potential in both grade and depth at the contact along the southern flank. However, new drilling also indicated the granite is deeper and lower-grade at the northern edge. Exploration crews also selected samples for assay from dewatering and geotechnical drilling in nine holes, primarily west of Fort Knox mine's open pit. Sampling was in support of the Gilmore project, which will extend the open pit to the west. Geological and assay data from these drill holes further refined the shape of the granite-schist contact and extended ore-shears to the west of the current reserve pit.

In June 2018, Kinross released an NI 43-101 technical report for Fort Knox mine and their Gil project about 7.8 miles to the northeast. The Gil property has been defined by a total of 735 drill holes (comprising 581 RC and 154 diamond holes) totaling 241,998 feet. Current resources are provided in appendix D. Re-logging and reinterpretation of the Gil-Sourdough deposit was carried out during 2018 in preparation for a 2019 drilling program. Re-logging identified a north-east-striking, steeply dipping fault system in the heart of the North Gil ore body.

Golden Summit

Freemgold Ventures Limited's intrusion-related Golden Summit property north of Fairbanks has an indicated resource of 67.7 million tons at 0.020 ounce of gold per ton (1,363,000 contained ounces of gold) and an inferred resource of 78.8 million tons at 0.020 ounce

of gold per ton (1,584,000 contained ounces of gold; appendix D). Metallurgical studies are underway and are aimed at improving the overall project economics.

Treasure Creek

Treasure Creek Partnership consolidated three properties in the Treasure and Any Creek watersheds north of Fairbanks that potentially host plutonic-related, lode-gold mineralization contained in three shear zones over a seven-mile-long strike length. Historical records indicate trench and drill intercepts contain assays close to or greater than 0.032 ounce of gold per ton over widths of 65 feet. In 2018 Treasure Creek conducted prospect-evaluation work. They successfully recovered old drill records and reverse-circulation drill cuttings from the early 1990s. With previously acquired drill-hole locations, Treasure Creek was able to construct a new revised interpretation and cross sections of the mineral systems, which have been and continue to be verified and examined in the field. Historical antimony-bearing prospecting trenches were re-exposed and systematically sampled to evaluate their gold potential.

Goodpaster District

Pogo

Northern Star reported that their investment strategy at Pogo mine, which they acquired in mid-2018, is generating outstanding exploration results. Northern Star conducted a \$23.64 million exploration- and concentrated infill-drilling campaign



Photo 10.

Northern Star conducted an extensive drilling campaign in 2018 at the Pogo mine in interior Alaska. Surface drilling concentrated on the new Central Lodes discovery. Photo from: Northern Star Resources Limited, September 27, 2018, Pogo gold mine site visit (presentation); last accessed October 4, 2018; www.nsrld.com/wp-content/uploads/2018/09/Pogo-Site-Visit-Presentation-27-09-2018.pdf.

using four underground rigs and four surface rigs. On the Pogo property, 693 diamond drill holes were completed for a total of 436,798 feet. Underground drilling focused on resource conversion and extension within the mine, while surface drilling concentrated around the new Central Lodes discovery located about 2,625 feet northwest of current underground development (photo 10). Northern Star conducted underground definition drilling totaling 575 holes for 257,533 feet, underground exploration with 32 holes totaling 32,310 feet, and surface exploration with 86 holes totaling 146,955 feet. Underground drilling focused on resource definition across the mine including Liese veins (L2, L3, Fun Zone), North Zone (NZ), and X-Vein (XV) together with extensional drilling down-dip on the L3 veins, and infill drilling at South Pogo in preparation for the commencement of mining activities.

Northern Star conducted drilling on the Liese Vein system, which has provided most of the 3.8 million ounces of gold produced at Pogo through mid-2018. In-mine drilling within the Liese Vein system (L1, L1.5, L2, and L3) continues to define and extend the limits of the interpreted vein structures. Drilling identified mineralized extensions of about 820 feet to the L2-07 and L2-08 Liese Vein in addition to extensions to the L1-01, L1-03, L1-09, and L1-13 vein surfaces; all of which will be incorporated into the revised resource estimate planned for release in August 2019. Significant Liese Vein system intersections include

- 19.0 feet grading 1.743 ounces of gold per ton,
- 73.8 feet grading 0.987 ounce of gold per ton,
- 21.0 feet grading 1.247 ounces of gold per ton, and
- 9.5 feet grading 2.129 ounces of gold per ton.

Underground diamond drilling, in conjunction with exploratory development, continued to extend the North Zone and X-Vein systems. The NZ/XV systems are atypical in that they dip steeply east, strike roughly north-south, and are cut by a series of graphitic shears. Quartz-vein textures vary from laminated to massive, with fracture-fill sulfides (pyrite, pyrrhotite,

arsenopyrite) commonly observed. In 2018, 92 holes were drilled to define and extend the NZ/XV systems. Significant intersections include

- 10.1 feet grading 1.188 ounces of gold per ton,
- 18.0 feet grading 0.526 ounce of gold per ton,
- 12.8 feet grading 0.698 ounce of gold per ton,
- 11.8 feet grading 0.733 ounce of gold per ton, and
- 3.6 feet grading 2.453 ounces of gold per ton (estimated true widths).

Northern Star also commenced long-hole open stoping production in the NZ area.

Access to the South Pogo vein system was achieved during 2018 via the 1706 exploration drive and L2X decline; mining of development ore commenced in mid-2018. As development advanced, numerous drill platforms were used to further extend and define the South Pogo/L2 Extended vein system. The South Pogo vein system (including L2 Extension) is interpreted to be a southern, offset block of the main Liese system. The main structural trends are consistent with the Liese zone, with two coherent stacked quartz vein structures identified to date; however, drilling indicates the presence of additional structures that require further testing. Mineralization within the South Pogo structural zone varies from coherent laminated quartz veins, to sulfidic silicified zones, to small-scale quartz-sulfide stockwork-type veins, to disseminated sulfides within silica-sericite alteration. Significant assays for South Pogo include

- 10.5 feet grading 0.835 ounce of gold per ton,
- 8.9 feet grading 0.876 ounce of gold per ton,
- 4.3 feet grading 1.553 ounces of gold per ton,
- 21.3 feet grading 0.315 ounce of gold per ton,
- 7.5 feet grading 0.800 ounce of gold per ton, and
- 7.9 feet grading 0.616 ounce of gold per ton (estimated true widths).

Fun Zone is a “Liese-style” vein system located above the Liese 1 block in the northwest portion of Pogo Mine operations. First ore

production from Fun Zone veins commenced in 2018, with drilling focused on ore reserve definition from the 1276 stope access and the 900 muck bay. Significant intersections returned from the Fun Zone include

- 11.2 feet grading 0.432 ounce of gold per ton,
- 9.2 feet grading 0.493 ounce of gold per ton, and
- 4.3 feet grading 4.219 ounces of gold per ton (estimated true widths).

The newly discovered “Central Lodes” vein system is located about 2,600 feet from existing mine infrastructure; it has been defined over a strike length of about 2,133 feet and a down-plunge extent of about 1,640 feet. The 47 holes drilled outline at least five individual stacked vein structures within the Central Lodes area, which are interpreted as a “Liese-style” faulted vein offset located northwest of the main system. Mineralization is similar in nature to the currently mined Liese veins. Individual quartz veins exhibit both laminated and granoblastic textures with a sulfide assemblage predominantly of pyrite, arsenopyrite, and pyrrhotite typically making up less than three percent of the mineralized intersections. A unit of highly altered granitic gneiss both influences the location of mineralized shoots within the vein structures and contains gold-bearing sulfide veinlets. The vein array remains open in all directions. A maiden resource is expected by mid-2019. Significant intersections from Central Lodes surface drilling include

- 6.6 feet grading 5.119 ounces of gold per ton,
- 11.8 feet grading 1.478 ounces of gold per ton,
- 46.9 feet grading 0.178 ounce of gold per ton,
- 6.6 feet grading 1.025 ounces of gold per ton, and
- 11.2 feet grading 0.783 ounce of gold per ton (estimated true widths).

Following the completion of the surface exploration drilling campaign, the four surface diamond drill rigs were refocused into the mine-lease area to undertake resource definition drilling on 98- to 164-foot centers in the new Strip Vein

project area. The Strip Vein area encompasses a series of moderately dipping, stacked vein arrays located immediately northwest of the main Liese Vein corridor.

In addition to their drilling program, Northern Star's review of historical drilling conducted by the previous owners identified more than 2,500 significant unmined intersections (defined as a minimum of 6.6 feet width grading 0.117 ounce of gold per ton) outside the current resource. Intersections include

- 39.4 feet grading 1.504 ounces of gold per ton,
- 24.9 feet grading 1.933 ounces of gold per ton,
- 7.5 feet grading 5.014 ounces of gold per ton,
- 19.4 feet grading 1.913 ounces of gold per ton, and
- 15.4 feet grading 1.486 ounces of gold per ton.

West Pogo

Millrock Resources Inc. re-logged historical trenches at their West Pogo gold property in the Big Delta Quadrangle in 2018.

Tibbs

Tectonic Metals, Inc. conducted exploration at their Tibbs gold project in the Big Delta Quadrangle, 22 miles southeast of Pogo mine. Their 3,840-acre property includes the Wolverine, Michigan, Blue Lead, O'Reely, Johnson Saddle, Hilltop/Oscar, Gray Lead, and Connector exploration targets as well as other geochemically anomalous areas. Work in 2018 included a property-wide DIGHEM magnetic–electromagnetic geophysical survey, 4,557 feet of trenching, collecting 106 auger soil samples and 459 rock samples, prospecting and geologic mapping, and satellite imagery interpretation. Trenching at the Gray Lead vein cut 26.2 feet of mineralization grading 0.432 ounce of gold per ton and 16.4 feet grading 1.110 ounces of gold per ton. A quartz–arsenopyrite–bismuth vein at the Connector prospect was trenched, and cut 19.7 feet grading 0.236 ounce of gold per ton and 42.7 feet grading 0.044 ounce of gold per ton. Trenching of 45.9 feet at Johnson Saddle discovered a new zone of mineralization associated with strong

carbonate alteration of the host-rock amphibolite, which contains elevated bismuth and 0.031 ounce of gold per ton. Four trenches at the Michigan prospect intersected up to 26.2 feet grading 0.030 ounce of gold per ton.

Healy Claims

Northway Resources Corp. entered into an agreement with Newmont North America Exploration Limited to explore Newmont's claims in the Big Delta Quadrangle southeast of Pogo mine. In 2018 Northway Resources collected 264 soil samples, 25 rock samples, and conducted geologic mapping and prospecting.

Richardson Subdistrict

Richardson

Northern Empire Resources Corp. released an NI 43-101 technical report in 2017 that contained recommendations for future exploration work at their Richardson property southeast of Fairbanks, which hosts multiple intrusion-related and low- and high-angle fault-hosted lode gold prospects; with gold \pm silver \pm arsenic \pm antimony \pm bismuth geochemical signatures, and geologic similarities to the Fort Knox and Pogo gold mines. The project area includes the historical Democrat lode gold mine hosted by a northwest-trending, 90 million-year-old, quartz-feldspar-porphyry dike. Coeur Mining, Inc. purchased Northern Empire in late 2018, and no exploration activities were conducted on the property.

Tower

Tower Exploration LLC, owner of claims covering the Tower/Junction prospect area adjacent to Coeur Mining Inc.'s Richardson property, extended their soil grid and conducted stream sediment sampling. The property is prospective for structurally controlled and intrusion-related gold mineralization.

Tolovana District

Livengood

International Tower Hill Mines Ltd.'s (ITH) advanced-exploration-stage, intrusion-related, Livengood gold project 70 miles northwest of Fairbanks has a mineral resource of 637 million

tons grading 0.020 ounce of gold per ton for 12.6 million ounces of contained gold, based on 783 drill holes totaling 717,435 feet, and a gold price of \$1,230 per ounce (appendix D). ITH made progress on several fronts, with studies designed to optimize the Livengood gold project and to reduce the costs of building and operating a mine. ITH contracted for additional metallurgical tests and engineering studies, including confirmation of the flow sheet and optimizing the operating costs. Using the improved mineralization and alteration models now available for the Livengood gold deposit arising from the extensive 2017 multi-element re-assaying program, ITH selected 8,818 pounds of metallurgical composites, and approximately half of this sample was processed in 2018 to evaluate optimum grind size and to determine whether different recovery parameters should be applied to different areas of the ore body. Further metallurgical work is ongoing, as are continued environmental baseline studies.

Shorty Creek

Freegold Ventures Limited conducted drilling on its Shorty Creek intrusion-related, copper-molybdenum-gold property approximately 78 miles northwest of Fairbanks. A total of 3,825.5 feet was drilled in two holes within the magnetic high at Hill 1835. Hole SC 18-01 was drilled to a depth of 1,821.5 feet and terminated in a significant fault zone: one 397.5-foot interval grades 0.45 percent copper, 0.0044 ounce of gold per ton, 0.307 ounce of silver per ton, and 0.045 percent tungsten. Hole SC 18-02, located 574 feet southeast of Hole SC 18-01, was drilled to a depth of 2,004 feet: one 413.4-foot interval grades 0.36 percent copper, 0.003 ounce of gold per ton, 0.184 ounce of silver per ton, and 0.018 percent tungsten. Additionally, metallurgical work is underway aimed both at determining copper, silver, and gold recoveries through locked-cycle testing, and at evaluating the potential for a gravity circuit to recover tungsten that occurs as wolframite, and hence is likely amenable to gravity recovery.

Elephant Mountain

Elephant Mountain, an early stage exploration project being conducted by Endurance Gold

Corporation, is centered on a Cretaceous, reduced intrusion-related gold system 76 miles northwest of Fairbanks. The Elephant Mountain project includes the Elephant Mountain property and the combined Wolverine–Trout properties, which are about five miles east–northeast of the Elephant Mountain property. Endurance's 2018 Wolverine–Trout exploration program, which covered the Trout Peak and South Fork Targets, consisted of hand excavation of trenches, rock sampling, in-fill soil sampling, portable XRF-supported geological mapping, prospecting, and additional claim staking (photo 11). Mapping identified a 1.1 mile by 0.74 mile, multi-phase, porphyritic syenite intrusion overlain by hornfels, as well as a north-east-trending zone of shearing and faulting over a strike length of 0.93 mile and a width of about 492 feet. Within the intrusion, the fault is coincident with the trend of a greater than 100 parts per billion gold-in-soil anomaly. One rock grab sample from silicified syenite within the Trout Shear assayed 0.672 ounce of gold per ton. One trench assayed 0.0149 ounce of gold per ton over 40 feet. At the South Fork target, rock sampling returned assays containing up to 0.302 ounce of gold per ton: mineralization is related to oxidized

sulfides associated with quartz veining, vein stockwork, and quartz-healed breccia hosted in hornfelsed clastic sediments. Chip sampling averaged 0.016 ounce of gold per ton over 30.8 feet. A comprehensive Elephant project technical report, completed during 2018, summarizes exploration activity to date by Endurance for both the Elephant and Wolverine–Trout properties.

McCord

Endurance Gold Corporation conducted orientation soil sampling work in August 2018 on their McCord property claims. These claims are located approximately seven miles southeast of International Tower Hill's Livengood intrusion-related gold deposit.

Peak (Tetlin) project

Peak Gold, LLC is a joint venture between Contango ORE Inc. and Royal Alaska, LLC, a wholly owned subsidiary of Royal Gold Inc., that was formed to explore the Tetlin project area near Tok. The project area contains the Main Peak and North Peak polymetallic gold–silver–copper skarn deposits, and numerous other prospects and prospective targets (photo 12).



Photo 11. Handheld XRF-supported geological mapping by geologist Cris Carman in 2018 at the Trout Mountain target, Elephant project, in interior Alaska. Elephant Mountain and Hutliana Creek in the background. Photo courtesy of Robert T. Boyd, Endurance Gold Corporation.

As of April 24, 2018, Royal Alaska had completed their \$30 million investment to earn a 40 percent interest in the joint venture, and the additional right to require Contango ORE to sell up to 20 percent of its interest in Peak Gold in a sale of Royal Alaska's entire 40 percent interest to a bona fide third-party purchaser. By late 2018, Peak Gold started looking at the potential to bring in a partner to help move the project forward.

Peak Gold published a preliminary economic assessment (PEA) in October 2018. The PEA considers a conventional truck-and-shovel open-pit mining operation covering the North, Main, and West Peak deposits that feeds a 3,858-tons-per-day processing plant with two-stage crushing, grinding, and a carbon-in-leach recovery circuit, and with gold-silver doré bullion production on site. The PEA is based on an update of the mineral resource estimate for the Peak and North Peak deposits that had been announced in June 2017. The resource estimate was updated using operating costs, pit slope estimates, and metal recoveries consistent with the PEA parameters in September of 2018, with measured and indicated resource estimates assuming metal prices of \$1,400 per ounce gold and \$20.00 per ounce silver for development of

the pit shell. The cut-off grades used to define resources were 0.0216 ounce of gold-equivalent per ton for the Main Peak deposit and 0.0193 ounce of gold-equivalent per ton for the North Peak deposit. Measured and indicated resources include 10,142,000 tons at a grade of 0.119 ounce of gold per ton, 0.414 ounce of silver per ton, and 0.153 percent copper, for contained metal of 1,208,100 ounces of gold, 4,198,800 ounces of silver, and 31.0 million pounds of copper. The inferred resource is 1,481,500 tons at a grade of 0.0785 ounce of gold per ton, 0.4690 ounce of silver per ton, and 0.151 percent copper, for contained metal of 116,400 ounces of gold, 694,100 ounces of silver, and 4.5 million pounds of copper (appendix D).

Highlights of the PEA include

- A pre-tax net-present-value (NPV), at five percent, of \$393 million and an internal rate of return (IRR) of 37.0 percent;
- An after-tax NPV of \$283 million and an IRR of 29.1 percent;
- An eight-year mine life with a 24-month pre-production period;
- Processing of 10.25 million tons of material at

Photo 12.

The Peak gold-silver-copper property in interior Alaska became available for sale in late 2018. Photo from: Royal Gold Inc., September 24, 2018, Peak gold project (presentation); last accessed October 19, 2018; www.royalgold.com/investors/events-and-presentations/eventdetails/2018/Denver-Gold-Forum-2018/default.aspx.



an average grade of 0.1165 ounce of gold per ton and 0.3416 ounce of silver per ton;

- Average metallurgical recoveries of 91.6 percent for gold and 57.0 percent for silver;
- A life-of-mine (LOM) recovery of 1.093 million ounces of gold and 1.996 million ounces of silver;
- A LOM strip ratio of 4.3 tons of waste/tons of material processed;
- A LOM total cash cost of \$428 per ounce of gold recovered, and \$470 per ounce of gold recovered including sustaining capital;
- A LOM capital cost of \$340 million, consisting of \$294 million of initial development capital, and sustaining capital and closure costs of \$46 million; and
- An after-tax payback period for initial development capital of approximately two years.

Peak Gold announced a \$9.1 million exploration budget, which included a 20,306-foot drilling program to investigate the potential for additional skarn mineralization in the area of the Peak deposits, as well as to evaluate the potential for porphyry or epithermal deposits at other targets across the larger Peak Gold land package. Work included about 46 line-miles of induced polarization (IP) and electromagnetic ground geophysics, which were carried out on potential skarn targets within a five-mile radius of Main Peak. Additionally, electromagnetic surveys were carried out on three porphyry targets identified from airborne geophysical surveys. The property's Copper Hill and North Saddle prospects were evaluated in the field for their potential to host porphyry mineralization. Drilling provided additional information on correlations between the gold, silver, and copper that was intersected, and the geophysical and geochemical signatures expressed at the surface. Additionally, 402 rock, 63 soil, 45 pan concentrate, and nine stream-sediment samples were collected on the Peak property.

Delta VMS

Agnico Eagle (USA) Limited's 2018 activities on their 100-percent-owned Delta VMS

project in the northern Alaska Range included creating an internal preliminary economic assessment and reinterpreting historical geophysical surveys to define future drilling targets.

Hajdukovich

Valhalla Metals Inc.'s Hajdukovich gold project, about 37 miles southeast of Delta Junction, is an early-stage exploration project encompassing multiple locations with greater than 0.1460 ounce of gold per ton over a 20-square-mile area. The property is dominated by a 3.1 mile by 9.3 mile, Paleocene, multi-phase, composite intrusive complex. Dominant phases include mafic and ultramafic intrusive rocks, diorite and monzonite, alkali feldspar granite, and megacrystic granite. These are cut by a variety of aplite, rhyodacite, rhyolite, and basalt dikes. Six distinctive but related styles of mineralization have been identified in the Hajdukovich project area: low sulfide gold-quartz veins, gold-sulfide-carbonate-quartz veins and veinlets, sulfide-quartz veinlets, gold- and platinum-group-element-bearing chalcopyrite-magnetite pods and veins, gold-bearing sulfide-quartz breccias, and gold-bearing semi-massive sulfides. In 2018 Valhalla re-logged historical core, conducted ASTER and LandSat image analysis, and identified future exploration targets.

Seventymile

Tectonic Metals, Inc. conducted exploration on their Seventymile gold project in the Eagle Quadrangle, 40 miles west of Eagle. Their Seventymile property includes the Flume Creek, Bonanza Creek, Alder Creek, Kill Zone 2, Flanders, Deer Creek, Ptarmigan Hill, and Mogul Bluff lode gold prospects. Work in 2018 included a magnetic survey with data collected along lines with 328-foot spacing, geological mapping and prospecting, 348 feet of trenching, collecting 71 rock samples, and collecting 380 auger soil samples along north-south-oriented lines with 82-foot sample spacing across lithology contacts.

Northway

Tectonic Metals, Inc. conducted exploration on their Northway copper-gold project along the

Alaska Highway in the Nabesna Quadrangle near Northway. The Northway property includes the Target 6, Road Metal, Target 7, and Yarger Lake prospects. The Road Metal prospect is interpreted to be the distal expression of a porphyry system and is associated with an aplite- and granite-clast breccia with a porphyritic granite matrix. Strong sericitization and silver–gold–base-metal mineralization are associated with the breccia. Work included a regional program of stream-sediment and pan-concentrate sampling, ridge-top auger soil sampling, prospecting, geologic mapping, 427 feet of trenching, and infill auger soil sampling at Target 6 and Target 7. A total of 48 rock samples, 952 soil samples, 282 stream-sediment samples, and 90 pan concentrate samples were collected. Targets 6 and 7 are both spatially associated with a deep IP anomaly and donut-shaped magnetic anomaly. Target 6 yielded gold-in-soil values up to 0.007 ounce of gold per ton and 0.06 percent copper; Target 7 yielded gold-in-soils up to 0.062 ounce of gold per ton.

Tanacross

Kenorland Minerals' Tanacross project's mining claims cover multiple porphyry prospects and occurrences in the northeastern Tanacross Quadrangle, including the Taurus copper–molybdenum–gold porphyry system, and the Bluff, East Dennison, PushBush, and Big Creek porphyry prospects. The Tanacross project area is located near the intersection of the northwest-trending, arc-parallel Big Creek fault system and the northeast-trending, arc-perpendicular Sixtymile–Pika fault. Kenorland interprets these regional structures as possibly controlling emplacement of mineral systems in eastern interior Alaska. 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.

In 2018 Kenorland continued to conduct soil sampling and geologic mapping on the property; following up on their 2017 work conducting

regional rock- and soil-geochemical sampling along ridgelines and spurs, documenting alteration, and mapping the location of volcanic and plutonic rocks.

McArthur Creek

K2 Gold Corp. staked claims and flew a lidar survey over their newly acquired McArthur Creek property in the eastern Tanacross Quadrangle. They own claims directly across the border in Yukon and are evaluating the region for its orogenic-gold-system potential.

Oreo

Tubutulik Mining Company LLC leased the Oreo property to Kennecott/Rio Tinto, which conducted grassroots exploration over the potential porphyry copper–gold target.

Golden Zone

Avidian Gold Alaska Inc.'s Golden Zone property, which is accessed by a 9.9-mile-long road extending west of the main highway between Anchorage and Fairbanks, 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; for a total of 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 that plunges northeast and is open at depth and along strike. The greater Golden Zone property contains skarn, carbonate replacement, and porphyry mineralization.

Avidian conducted reconnaissance prospecting, geophysical surveying, trenching, and drilling in 2018. Avidian's 28.6-line-mile controlled-source audio-frequency magnetotelluric (CSAMT) survey over the 1.86-mile-long Copper King, Long Creek, and South Long Creek trend identified multiple resistivity highs; many corresponding with aeromagnetic lows and coincident with known mineralization. Avidian discovered their new JJ Zone, which is hosted by sandstone

intruded by multiple intermediate dikes (photo 13). The exposed zone forms a northeast-striking, sub-vertical plane approximately 492 feet wide and about 984 feet high, and a strike length of at least 1,640 feet. Eight grab samples assayed greater than 0.0277 ounce of gold per ton, with a high value of 0.1793 ounce of gold per ton.

Avidian also excavated 16 trenches and collected 765 channel samples in the Copper King, Mayflower Extension, Long Creek, and South Long Creek areas. Copper King trenches T18-09 to T18-11 and T18-14 produced the best results to date. T18-09 intersected 98.4 feet grading 0.0654 ounce of gold per ton, 2.1637 ounces of silver per ton, and 2.79 percent copper in semi-massive sulfide (skarn) with a combination of chalcopyrite, pyrrhotite, and gangue minerals. T18-10 intersected 88.6 feet grading 0.0038 ounce of gold per ton, 0.1440 ounce of silver per ton, and 0.20 percent copper, and is semi-contiguous with T18-09. T18-14 intersected 29.5 feet grading 0.0155 ounce of gold per ton, 0.2575 ounce of silver per ton, and 0.22 percent copper in disseminated and stringer mineralization in siltstone. Trench T18-11, with mineralization disseminated in conglomerate, intersected 68.9 feet

grading 0.0038 ounce of gold per ton, 0.3816 ounce of silver per ton, and 0.45 percent copper; this is considered encouraging because conglomerates comprise a significant part of the property's stratigraphy and have not been specifically targeted for exploration. One trench at Mayflower Extension intersected 9.8 feet grading 0.1509 ounce of gold per ton. Trench T18-05 adjacent to Long Creek intersected 9.8 feet grading 0.4695 ounce of gold per ton, 1.4775 ounces of silver per ton, and 0.78 percent copper, with arsenopyrite stringers in conglomerate. Trenches at South Long Creek tested arsenopyrite-bearing veins, which are silver-rich and contain anomalous gold.

Avidian drilled ten holes totaling 9,255 feet in the Breccia Pipe deposit, and Mayflower Extension, Copper King, and Long Creek prospects. Hole GZ18-04, drilled down the plunge of the Breccia Pipe deposit, intersected 70.8 feet grading 0.0485 ounce of gold per ton on the pipe's margin, mostly in the monzodiorite host intrusion. The high-grade part of the pipe yielded 352.1 feet grading 0.1390 ounce of gold per ton in sulfide-rich breccia. An area of intrusive rock, well below the known Breccia Pipe, contains arsenopyrite-rich veins and intersected 19.2 feet



Photo 13.

The JJ Zone, a newly discovered target at the Golden Zone property in the west-central Alaska Range, is hosted by gold-bearing altered sandstone intruded by intermediate dikes. Photo courtesy of Tom Setterfield, Avidian Gold Alaska Inc.

grading 0.0876 ounce of gold per ton, which suggests that this intrusion has not been adequately drilled out and has the potential to add additional ounces to the existing resource.

At Copper King, hole CK18-01 twinned and extended prior hole CK94-02. CK18-01 was collared into semi-massive sulfide, and one 29.9-foot intersection graded 0.2543 ounce of gold per ton, 2.359 ounces of silver per ton, and 3.57 percent copper. Hole CK18-02, collared in quartz-eye porphyritic granite, locally contains stockwork veining with anomalous gold (11.3 feet grading 0.023 ounce of gold per ton), but more commonly molybdenite and chalcopyrite are present (photo 14).

Mayflower Extension hole GZ18-01, drilled underneath prior hole GZ17-10, returned several narrow anomalous-gold intersections; suggesting that mineralization may pinch and swell. Hole GZ18-02 intersected 18.8 feet grading 0.1086 ounce of gold per ton and 58.1 feet grading 0.0619 ounce of gold per ton in sediments. Avidian's three drill holes in the Long Creek area tested CSAMT apparent resistivity highs (possible intrusions) juxtaposed with resistivity lows (possible sulfides). Hole LC18-01 intersected a 36.2-foot interval of conglomerate with disseminated

chalcopyrite grading 0.010 ounce of gold per ton and 0.38 percent copper.

Alaska Range Project

PolarX's Alaska Range project includes the sediment-hosted-copper Caribou Dome deposit with a 2017 JORC-compliant resource of 3.1 million tons grading 3.1 percent copper (0.5 percent lower cut-off grade) for contained metal of approximately 190 million pounds of copper (appendix D). This project also encompasses the Senator prospect; the Zackly copper–gold skarn deposit; the Saturn, Jupiter, Mars, and Gemini porphyry copper–gold–molybdenum targets; and the gold-only Moonwalk target. These properties fall within a 21.7-mile-long, north-east-trending corridor of elevated copper ±gold in soils. In March 2018, PolarX released the first JORC-compliant inferred resource estimate for the Zackly skarn deposit, which includes 3.75 million tons grading 1.2 percent copper, 0.058 ounce of gold per ton, and 0.409 ounce of silver per ton—for 90.9 million pounds contained copper, 213,000 ounces of gold, and 1.5 million ounces of silver (0.5 percent copper cut-off grade; appendix D).

PolarX's 2018 exploration program included staking additional claims to cover potential extensions of the copper-in-soils anomaly at Senator and the Mars–Zackly–Saturn corridor (photo 15). IP data previously collected over the Zackly and Mars prospects were re-processed for incorporation into 3D-models for drill-hole targeting, regional aeromagnetic data were re-processed, and new imagery was examined for structural lineaments and intrusive centers. A 164-foot line-spacing aeromagnetic survey was flown at an average height of 108 feet above the ground over the northeastern half of the project area to better define mineralized structures at Zackly and to facilitate evaluation of other potential porphyry intrusions and major structural zones. Over 200 soil samples were collected from a



Photo 14. Molybdenite in stockwork veins of altered quartz-eye porphyry from drill hole CK18-02, from the Copper King prospect at the Golden Zone property. Photo courtesy of Tom Setterfield, Avidian Gold Alaska Inc.

656-foot by 492-foot area over the Mars copper–gold target, which is part of a larger 1.24 mile by 0.93 mile copper–gold–molybdenum–arsenic soil anomaly overlying IP and magnetic highs, as well as 52 rock-chip samples collected from selected outcrops of variably mineralized veins and breccias in creek beds and on ridges. Rock-chip sampling was also undertaken at the Moonwalk gold target.

PolarX drilled a total of 11,680 feet in 18 HQ-diameter holes utilizing two drill rigs at Zackly (figure 6). Holes ZX-18018 and ZX-18032 intersected multiple zones containing copper and gold mineralization 328 feet below the nearest hole in the JORC resource at Zackly, which will likely lead to an increase in the inferred resource. Along strike and up to 2,789 feet east of the Zackly inferred resource, PolarX's drilling encountered significant skarn mineralization. Hole ZX-18020 intersected 180.4 feet grading 0.082 ounce of gold per ton and 0.6 percent copper 8.2 feet below the surface, and ZX-18024 intersected 153.2 feet grading 0.090 ounce of gold per ton and 0.6 percent copper.

Liberty Bell

Millrock Resources Inc.'s Liberty Bell project 70 miles southwest of Fairbanks has geophysical signatures and numerous intermediate to felsic dikes, sills, and plugs, as well as widespread gold–copper anomalies with tourmaline that suggest the presence of high-level alteration–mineralization associated with a porphyry copper–gold and distal skarn system. In 2018 Millrock conducted IP surveying, an in-fill rock and soil geochemical survey, prospecting, and geologic mapping. The results fine-tuned the prospect areas for targeting future drilling. Millrock also compiled and standardized many years of historical company data into GIS using the DGGs Liberty Bell bedrock geologic maps' lithology scheme. Millrock also staked additional claims to increase their land package. Joint-venture partner Kinross Gold U.S.A., Inc. funded the 2018 exploration project but terminated its option near year end.

Red Mountain/Bonnifield

White Rock Minerals Ltd. explored their Red Mountain project in the northern Alaska



Photo 15.

Reconnaissance at PolarX's Zackly copper–gold skarn deposit in the central Alaska Range. Figure source: PolarX Limited; last accessed September 20, 2019; www.polarx.com.au/wp-content/uploads/2017/01/displayer-1.jpg.

Range in 2018. The property hosts numerous polymetallic VMS deposits, prospects, and occurrences. The Red Mountain area's two known VMS deposits have JORC-compliant resources: Dry Creek (101 historical drill holes for a total of 45,380 feet) and West Tundra Flats (26 historical drill holes for 17,550 feet). At a three percent cut-off grade, the main Dry Creek deposit contains an inferred resource of 2.646 million tons at 4.7 percent zinc, 1.9 percent lead, 0.2 percent copper, 2.01 ounces of silver per ton, and 0.012 ounce of gold per ton for 254 million pounds of zinc, 101 million pounds of lead, 11 million pounds of copper, 5.3 million ounces of silver, and 32,000 ounces of gold. The West Tundra Flats deposit contains an inferred resource of 7.385 million tons at 6.2 percent zinc, 2.8 percent lead, 0.1 percent copper, 5.51 ounces of silver per ton, and 0.032 ounce of gold per ton for 917 million pounds of zinc, 414.5 million pounds of lead, 15 million pounds of copper, 40.8 million ounces of silver, and 229,000 ounces of gold (appendix D).

White Rock Minerals Ltd. conducted a diamond drilling program with associated down-hole electromagnetic measurements in 2018; a total of

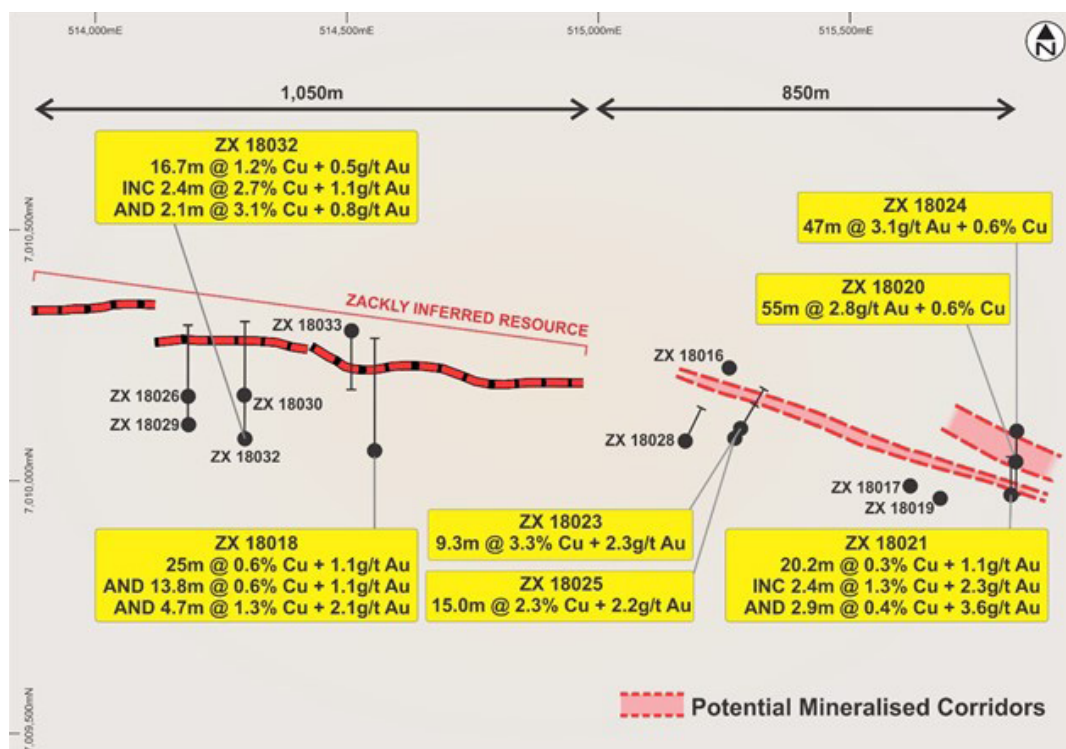
24 holes covering 13,488 feet. Drilling included in-fill and expansion of the 2017 maiden resource at the Dry Creek and West Tundra Flats deposits, and exploration drilling at the Dry Creek South, Dry Creek West, Hunter, Redback, Ram, Megan's South, and South Platypus prospects. Drilling highlights include

- West Tundra Flats hole WT18-28 intersected 11.3 feet grading 15.1 percent zinc, 6.7 percent lead, 15.1 ounces of silver per ton, 0.061 ounce of gold per ton, and 0.2 percent copper;
- Discovery Lens at Dry Creek, hole DC18-79, intersected 15.4 feet grading 19.5 percent zinc, 7.8 percent lead, 13.6 ounces of silver per ton, 0.202 ounce of gold per ton, and 1.5 percent copper; and
- The down-dip extension of the Fosters Lens at the Dry Creek deposit intersected 14.1 feet grading 4.8 percent zinc, 2.3 percent lead, 41.9 ounces of silver per ton, 0.064 ounce of gold per ton, and 0.5 percent copper.

In August 2018, White Rock announced their discovery of the Hunter prospect with a 23-inch-thick massive sulfide outcrop that extends over 1,640 feet of strike and is hosted

Figure 6.

Plan map showing the surface trace of the Zackly inferred mineral resource, 2018 drill-hole collars, and key assay results. PolarX, January 31, 2019, December 2018 quarterly activities report; last accessed February 8, 2019; wcsecure.weblink.com.au/pdf/PXX/02071664.pdf.



within a graphitic schist that can be traced over 0.6 mile of strike. Rock chip sampling from the discovery outcrop and trenching along strike—to define the position of the massive sulfide mineralization—returned assay results up to 18.6 percent zinc, 5.4 percent lead, 2.3 percent copper, 4.29 ounces of silver per ton, and 0.020 ounce of gold per ton. CSAMT geophysics exhibits a subtle conductivity anomaly coincident with the massive sulfide. Three holes were drilled, and hole HR18-01 intersected 4.6 feet grading 17.4 percent zinc, 3.9 percent lead, 2.628 ounces of silver per ton, and 1.6 percent copper.

The company also conducted 25-line-miles of ground-based CSAMT geophysical surveys, a detailed regional stream-sediment program across their 56.8-square-mile land package, and reconnaissance geologic mapping and rock and soil geochemical sampling on target areas with coincident conductive geophysical and surface geochemical anomalies. Field crews collected a total of 435 stream samples, 1,835 soil samples, and 330 rock chip samples.

Sandfire Resources became a significant investor and strategic partner in the Red Mountain project and, in December 2018, exercised its option to enter into a joint venture agreement with White Rock Minerals. White Rock also staked an additional 524 claims over a number of additional nearby VMS mineral occurrences including Anderson Mountain, Virginia Creek, West Fork, Peaches, Keevy Peak, Kenny, Sheep Creek, and Surprise Creek; thereby increasing their total land package to 183 square miles. These prospects have been the subject of past exploration, including mapping, rock-chip sampling, and, in some cases, drilling.

Emerick/Forbes area

Northridge Exploration conducted prospecting and soil sampling at its mafic and ultramafic rock-associated, copper–nickel–cobalt–platinum-group-element (PGE) prospects that are part of the Wrangellia Terrane in the central Alaska Range (photo 16). Sixty feet east of the Forbes

prospect, one sample assayed 4.5 percent nickel, 2 percent copper, and had PGE credits. The company also reported discovering 'chicken blood-stone,' a bright red material hosted in veins that may be used as a semi-precious carving material.

Tres Equis

Northridge Exploration conducted prospecting at its Tres Equis copper–nickel–PGE prospect hosted in mafic–ultramafic rocks, which are part of the Wrangellia Terrane in the central Alaska Range.

Honolulu

The Honolulu property, located five miles east of the Parks highway in south-central Alaska, hosts a structural zone with anomalous silver, lead, zinc, copper, and gold. In 2017 Honolulu Prospect Corp. conducted an extensive surface-sampling program that defined a 1,000-foot-long and up to 200-foot-wide mineralized structural zone with multiple mineralized fault splays that contain continuous high-grade mineralization. The project also identified four new areas with anomalous silver, copper, and gold. Select sheeted arsenopyrite veins from Tiki Chute contain up to 0.17 ounce of gold per ton and 1.35 ounces of silver per ton. Disseminated arsenopyrite in drusy quartz from Bertram Gulch contains 0.03 ounce of gold per ton and 7.3 ounces of silver per ton. Oxidized sulfide veins from Tempest contain up to 8.26 percent lead, 6.47 percent zinc, and 223.8 ounces of silver per ton. Honolulu Prospect Corp. conducted a drill program in 2018 to test previously defined geochemically anomalous areas.

Valdez Creek Lode

In upper Valdez Creek in the south-central Alaska Range, claims covering a known lode-gold deposit and other prospective areas are controlled by Valdez Creek Mining. Placer gold in Valdez Creek is derived from this lode-source area. Canalska's historical exploration drill program identified five vertically stacked, gold-bearing zones over a vertical distance of 600 feet with a strike length of over 900 feet. In 2018 Valdez Creek Mining drilled 23 holes totaling

16,059 feet at their Lucky Saddle prospect and seven holes totaling 3,980 feet at their Lucky Top prospect. Exploration work also included limited prospecting at their Timberline prospect.

South-Central Region

Johnson Tract

Constantine Metal Resources Ltd. signed a Letter of Agreement with Cook Inlet Region, Inc. (CIRI) in June 2018 for lease rights to the 20,942-acre Johnson Tract property 125 miles southwest of Anchorage. The Johnson Tract deposit is a gold- and base metal-rich, quartz-vein stockwork hosted in Jurassic volcanoclastic rocks. Mineralization is interpreted to have formed in a sub-seafloor setting contemporaneous with the host stratigraphy. There are at least nine other prospect areas of alteration and mineralization to the southeast and north of the Johnson Tract deposit over a 7.5-mile strike length.

The Johnson Tract gold–silver–zinc–copper–lead deposit was discovered by Anaconda in 1982. Past work includes 88 drill holes for a total of 88,058 feet, as well as major engineering- and mining-related studies. Historical drill holes returned significant mineralized intercepts: JR88-34 with 234.3 feet grading 0.611 ounce of gold per ton, 5.21 percent zinc, 1.23 percent copper, 1.51 percent lead, and 0.287 ounce of silver per ton; JR82-4 with 336.6 feet grading 0.319 ounce of gold per ton, 8.01 percent zinc, 0.75 percent copper, 2.13 percent lead, and 0.248 ounce of silver per ton; and JR93-65 with 327.1 feet

grading 0.312 ounce of gold per ton, 6.34 percent zinc, 0.90 percent copper, 1.27 percent lead, and 0.195 ounce of silver per ton. The Difficult Creek prospect area contains several surface showings about 2.8 miles northeast of the Johnson Tract deposit. Drill hole DC-02 at the Difficult Creek prospect returned 42.7 feet grading 0.250 ounce of gold per ton, 4.7 percent zinc, 0.5 percent copper, 0.9 percent lead, and 1.10 ounces of silver per ton. The project reverted back to CIRI in the late 1990's. In late 2018, Constantine conducted a drill-core re-sampling program taking 426 samples across nine drill holes.

Genesis

The Genesis project area was staked by Anglo Alaska Gold Corp. New Age Metals, Inc. acquired a 100-percent-interest purchase option in April 2018. New Age Metals Inc. conducted a surface-sampling program to evaluate the nickel–copper–chromium–PGE potential of numerous prospects at their Genesis project, which is hosted by the Tonsina mafic–ultramafic complex just east of the Richardson Highway and 75 miles north of Valdez. Two mineralization styles are recognized: chromite-associated platinum and palladium, and stratabound nickel–copper–PGE, which has been identified in outcrop sampling for 2,800 feet along strike and has a 130-foot true thickness. New Age also released a technical report summarizing the property's historical exploration and geologic data.

Opal

The Opal gold–silver prospect, located in the headwaters of Liberty Creek near Chitina, Alaska is being evaluated by Ben Porterfield. High-angle, gold-bearing, polymetallic quartz veins cut an altered Eocene sill, which intrudes schist of the Liberty Falls Terrane. The high-angle quartz veins are typically less than a foot wide and occur in sub-parallel sets. Minor galena occurs in the veins along with sphalerite, pyrite, and arsenopyrite. Vein samples assay up to multiple



Photo 16. Copper–nickel–PGE-mineralized sample from the Forbes prospect in the central Alaska Range. Photo courtesy of David H. Johnson, Northridge Exploration.

ounces of gold and visible gold is common. In 2018, gravity separations were made from a bulk tonnage sample collected the prior year.

Icy Cape

The Icy Cape gold and heavy mineral beach-placer property, located in the Gulf of Alaska near Icy Bay about 75 miles northwest of Yakutat, is owned by the Alaska Mental Health Trust Authority and managed by the Trust Land Office (TLO). The area has been explored and mined for placer gold since the early 1900s. In 2015, TLO initiated their Icy Cape Gold and Industrial Heavy Minerals project; which is designed as 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. During investigations to date, TLO has identified platinum-group metals in heavy mineral concentrates, tested garnet concentrates as abrasive media (they met industry standard SSPC-AB1), and evaluated epidote-group minerals for use as abrasive media and for water filtration and purification media.

Beach sediments are present from the current shoreline to almost three miles inland, where ancient beach sediments occur in coast-parallel terraces. Gold- and industrial mineral-bearing sequences are located in stacked shorelines over 200 feet above sea level. In 2016, TLO had DGGS contract for a low-altitude, high-resolution aeromagnetic survey over the Icy Cape property. Magnetic-high anomalies are interpreted to spatially coincide with heavy mineral concentrations, and along with TLO's geologic models, were used to help locate drill targets.

The TLO's 2018 Icy Cape project had a crew of 24, and workers built a 60-foot by 40-foot sample-processing facility. They conducted a 6,500-foot sonic drilling program with 8-inch-diameter core in the western and eastern portions of their land block (photo 17). Their geological "deposit" model, backed up by aeromagnetic models, is proving up, and was used to confirm projected gold-, garnet-, and

epidote-minerals-bearing beach sediments. TLO continued to explore the new discovery, the gold, and heavy minerals-containing sediments below projected geophysical targets.

Southwestern Region

Donlin

Donlin is a proposed large open-pit gold mine in southwest Alaska, which is owned by Donlin Gold, LLC, a 50/50 partnership between Barrick Gold Corporation and NovaGold Resources Inc. The deposit contains proven and probable reserves of 34 million ounces of gold at an average grade of 0.06 ounce of gold per ton (appendix D). The total advanced-stage exploration and development budget for the Donlin Gold project for 2018 was \$22 million. Several key federal and state permits were secured by Donlin Gold in 2018. The final EIS was published, and 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 and section 10 of the Rivers and Harbors Act. BLM issued the Offer to Lease for the Right-of-Way for the portion of the proposed natural gas pipeline crossing federal lands, and the Pipeline and Hazardous Materials Safety Commission issued a special permit for the pipeline. Major State permits that were issued are: section 401 CWA Certificate of Reasonable Assurance; the Alaska Pollutant Discharge Elimination System water discharge permit; and Department of Fish and Game's Title 16 Fish Habitat permits for the mine area and transportation corridor. The Department of Environmental Conservation approved an extension of the date by which the Donlin Gold project must begin to June 30, 2020, as authorized by the Prevention of Significant Deterioration air-quality permit.

Pebble

The Pebble porphyry copper–gold–molybdenum deposit in southwestern Alaska is currently one of the world's most significant undeveloped deposits of copper, gold, and molybdenum, with a total endowment of 82.0 billion pounds of copper and 106.5 million ounces of

Photo 17.

The Mental Health Trust Authority's Trust Land Office conducted a 6,500-foot sonic drilling program with 8-inch-diameter core in the western and eastern portions of their Icy Cape beach-placer property in the Gulf of Alaska. Photo courtesy of Karsten Eden, Trust Land Office.



gold (appendix D). The Pebble Limited Partnership (PLP) has invested more than \$800 million in the Pebble project; principally on geological, environmental, engineering, and other technical studies aimed toward the development of an environmentally sound and socially responsible mine plan (photo 18).

In May 2017, PLP announced an agreement with the U.S. Environmental Protection Agency (EPA) to resolve the preemptive actions taken by the EPA against the Pebble project. In July 2017, the EPA initiated steps to withdraw its proposed determination restricting development at the Pebble project under Section 404(c) of the U.S. Clean Water Act (CWA). The PLP filed for a CWA 404 permit with USACE on December 22, 2017—thereby initiating federal and state permitting for the Pebble project under NEPA. As part of the NEPA review process, and to support other permitting efforts, PLP also submitted a Project Description that summarizes information about the environmental setting, engineered facilities, and operations for the proposed Pebble project from initial construction through closure and reclamation.

The USACE released a Notice of Intent to the United States Federal Register in March 2018 that initiated the process to prepare an EIS. Scoping comments were accepted April 1 through June 29, 2018, to offer the public the chance to comment on the proposed project and alternatives. The USACE then determined the alternatives to analyze and started preparing the Draft EIS immediately following the scoping period. The Draft EIS is scheduled for release by the USACE in early 2019; it is intended to disclose the likely impacts from the proposed project and to offer the public and governmental agencies the chance to review and comment during the scoping period. The Final EIS will address all substantive comments on the Draft EIS and is estimated to be released in early 2020.

Alaska's DNR issued PLP a permit to carry out exploration and reclamation activities during the 2018 field season. DNR plans multiple inspections during 2018 to monitor both the drilling of new boreholes and continued PLP reclamation activity.

In 2018 Alaska Peninsula Corp. (APC), which represents five Alaska Native village



Photo 18. Pebble Limited Partnership conducted drilling at the Pebble deposit in southwestern Alaska in 2018. Photo source: Pebble Limited Partnership; last accessed September 21, 2019; pebblepartnership.com/photos.

corporations in the Bristol Bay region, granted PLP a secure right to use defined portions of APC lands for future development of transportation infrastructure if the proposed mine is successfully permitted and developed. Under this agreement, APC will receive annual toll payments and other fees paid by PLP prior to and during project development. PLP has also agreed to negotiate a profit-sharing agreement to ensure APC and its shareholders benefit directly from mining profits. APC has negotiated a deal with PLP that provides them with a preferential opportunity to bid on Pebble-related contracts on its lands.

Luna-Quicksilver-Kisa

Riversgold Ltd. conducted exploration on their Luna, Quicksilver, Luna East, Gemuk, and Kisa properties 81 miles south of Aniak, where Late Cretaceous and Tertiary plutons, volcanic-plutonic complexes, and extensive dike and sill swarms are present (photo 19). The project area contains 12 miles of strike of the North Fork fault (a mineralized, subsidiary splay of the Denali-Farewell fault) and the North Fork granite pluton. The project area is characterized by outcropping high-grade gold \pm polymetallic mineralization.

Riversgold completed an IP survey over Luna and Luna East, which was designed as a grid of 1,312-foot-spaced NW–SE lines, orthogonal to the main fault structures, with stations spaced at 164 feet along the lines. Following identification of at least two N–S structures, several E–W follow-up lines were also completed. Rock-chip and soil sampling at Quicksilver identified multiple outcropping massive arsenopyrite veins averaging 0.234 ounce of gold per ton and several large gold–arsenic–bismuth–copper–antimony soil anomalies with up to 0.075 ounce of gold per ton. Rock chip and soil sampling at Gemuk increased the strike of high-grade gold mineralization to at least 1.2 miles along the Pluton fault and outlined a new 1,312-foot-long gold–arsenic–antimony soil anomaly with up to 0.037 ounce of gold per ton. Rock chip sampling at Kisa returned several high-grade gold results—up to 0.355 ounce of gold per ton—from a series of mineralized quartz–feldspar porphyry dykes. Riversgold also staked new claims over high-grade gold mineralization discovered at Midway Hill; rock-chip sampling returned several high-grade results up to 0.340 ounce of gold per ton from outcropping epithermal quartz veins.

Riversgold drilled three holes for a total of 1,167 feet at Luna, Luna East, and Quicksilver.

Photo 19.

Setting out the grid baseline at the Luna prospect in southwestern Alaska. Photo source: Riversgold Ltd., last accessed October 18, 2018; www.riversgold.com.au/sites/default/files/asx-announcements/1818386.pdf.



East Luna hole LQDD002 intersected quartz–feldspar porphyry dikes with abundant disseminated arsenopyrite and minor pyrrhotite and chalcopyrite, and two zones of semi-massive pyrrhotite with pyrite and chalcopyrite. LQDD001, testing beneath the main Luna outcrop, was drilled to a depth of 417 feet and encountered variably altered quartz–feldspar porphyry dikes with disseminated pyrite. Quicksilver hole LQDD003 intersected biotite granite intruded by a series of quartz–feldspar porphyry dikes and several arsenopyrite veins; some with colloform-banded quartz similar to those outcropping at surface.

Terra

West Mountain Gold conducted ground-based geophysical surveying and drilled ten core holes for a total of 7,972 feet on their structurally controlled, high-grade Terra gold vein system in the western Alaska Range.

Estelle & Farewell Projects

Nova Minerals Limited explored their Estelle gold project in the western Alaska Range approximately 110 miles northwest of Anchorage. There are multiple prospects within the Estelle project area: Oxide (Oxide Ridge, Oxide Valley, Oxide North, and Oxide South); Stoney (Stoney, Tomahawk, Kid, and Trundle); Mount Estelle (Mount Estelle, Shoeshine, and Train); and Emerald (RPM and Revelation). In 2018 Nova

Minerals conducted chip sampling and geologic mapping in the Oxide prospect area. Locally abundant sulfide mineralization and associated quartz stockwork were sampled in a north–north-east-trending zone within the multi-phase Late Cretaceous Mount Estelle pluton. All mineralization is hosted in phaneritic intrusions, and phyllic and propylitic alteration were recognized in sulfide-rich zones. Sampled zones include the Oxide-North and Oxide-South prospects and a new zone tested by Nova Minerals. Chip samples were collected across sulfide-rich areas with locally abundant arsenopyrite, chalcopyrite, tetrahedrite, pyrite, and/or pyrrhotite. Previously identified chargeability anomalies were also sampled. Seventy-five samples were submitted for ore-geochemistry analysis and, where appropriate, for major- and minor-oxide analysis to better understand the geochemical composition of the mineralized intrusive suite. Three bulk pan-concentrate samples were acquired from the main stream drainage cutting the claim group.

**Southeastern Region
Greens Creek**

Hecla Mining Company spent \$3.15 million on exploration at their Greens Creek mine southwest of Juneau, which contains numerous underground VMS ore bodies. Definition and exploration drilling continues to identify and

refine resources, and to replace and add new reserves, keeping reserves well ahead of production. Total exploration-drilling footage was 33,135 feet, which consists of 20,492 feet of surface and 12,643 feet of underground drilling. Exploration drilling focused on the Deep 200 South, Deep Southwest, Lower Southwest, and Gallagher fault block. Definition drilling refined the resources of the East Ore, East, Deep Southwest, Deep 200 South, Gallagher, NWW, Southwest Bench, and Upper Plate ore zones.

In the first quarter of 2018, definition drilling expanded the resources for East Ore, Deep 200 South, Gallagher, East, and Upper Plate zone. Highlights are: East Ore Zone definition-drilling intersections compared favorably to previously modeled resource estimates, and step-out drilling suggested that mineralization continues beyond the resource to the south and at depth. Southern Deep 200 South Zone

definition drilling confirmed high grades and upgraded the mineralization to the indicated resource. Gallagher Zone drilling confirmed modeled thicknesses and may have increased the resource by defining mineralization further to the west beyond the current resource.

In the second quarter, definition drilling expanded the Deep 200 South, Gallagher, East Ore, Upper Plate, and Southwest Bench zone resources (figure 7). Highlights are: Lower Southwest Zone drilling indicated that the newly-defined, lower ore band extends farther to the north and higher in elevation than modeled. Recent drilling of the upper remnant limb of the lower Southwest Zone showed that the mineralization is much thicker than anticipated. Surface drilling commenced in June and the first three drill holes intersected broad zones of stockwork veining and 3- to 5-foot-wide bands of semi-massive sulfide containing significant sphalerite, galena, and silver sulfosalts; this semi-massive sulfide zone is about 800 feet west of the current 200 South Bench resource.

In the third quarter, definition drilling and strong assay results from drilling in the previous quarter expanded the Deep 200 South, NWW, East Ore, Upper Plate, and Southwest Bench zone resources. Exploration drilling focused on the Deep 200 South Zone, Gallagher Fault Block, and Deep Southwest Zone. Highlights follow: Deep 200 South Zone definition drilling confirmed three flat-lying, high-grade lenses that are folded to the west and enabled portions of bench mineralization to be upgraded to an indicated resource category. The first surface drill holes southwest of the Upper Plate Zone resource defined two mineralized limbs of a fold that are present over 200 feet from the current resource and remain open to the south, north, and west. Much of the mineralization is proximal to the mine contact, but mineralized zones are also present within the argillites; mineralized zones are 4–11-feet thick and transition from white carbonate ore to massive base-metal ore and mineralized argillite. Surface drilling identified the western extension of the 200

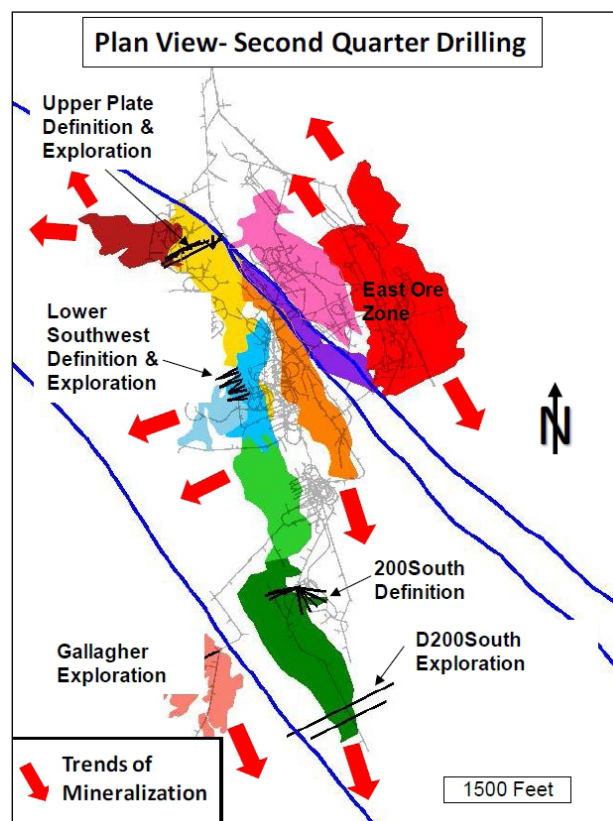


Figure 7. Greens Creek plan map showing location of ore bodies. Figure source: Hecla Mining Company; last accessed November 26, 2018; [ir.hecla-mining.com/file/Index?KeyFile=394533805](https://www.hecla-mining.com/file/Index?KeyFile=394533805).

South Bench mineralization 700–900 feet west of the current resource, which may represent part of a bench syncline that is over 1,000 feet by 750 feet in area and could add considerably to future resources. Higher up in these surface holes, mineralization was intersected at the mine contact and west of the Gallagher fault. This is the first time that mineralization has been intersected west of the Gallagher fault this far north (1,800 feet north of the Gallagher Zone mineralization); potentially opening up a large area for prospective exploration.

In the fourth quarter, definition drilling expanded the Deep 200 South, East Ore, Upper Plate, and Southwest Bench zone resources. Exploration drilling focused on the Deep 200 South Zone and Lower Southwest Zone. Highlights follow: Near the mine portal elevation, Upper Plate Zone drilling defined at least two flat-lying zones that are folded to the east. In combination with surface drilling earlier in the year, this resource expanded further to the west and north. Definition drilling results indicated a thickening of the upper and middle mineralization horizons toward the Southwest D fault from the east toward the fault.

Kensington

Coeur Alaska Inc. spent \$5.9 million on exploration drilling covering 57,942 feet and \$4.4 million on 35,294 feet of conversion drilling to expand and define mineralization in the main Kensington and Raven deposits north of Juneau. The geology team also initiated a district-wide exploration program to identify and map new vein targets. Several new potential

high-grade-gold vein targets were drilled, including Elmira, Ophir, and Seward (photo 20). As of year-end 2018, 11 holes had been drilled and assayed on the Elmira prospect from two stations underground. Results confirmed the existence of a mineralized zone approximately 1,300 feet east of existing underground infrastructure. Several high-grade intercepts were returned with overall zone morphology strongly resembling Kensington's Zone 10. Significant intercepts were noted in eight of these holes, including 14.3 feet grading 1.01 ounces of gold per ton and 12.8 feet grading 1.05 ounces of gold per ton. Drilling confirmed that the Elmira vein remains open to growth in all directions.

The Ophir prospect outcrops on the surface as an 8-foot-thick vein near existing Kensington infrastructure. Surface drilling confirmed its continuity throughout the seven completed surface drill holes; significant assay results were returned from one drill hole. Additional underground drilling was underway at year-end to develop a better understanding of the vein's morphology and grade distribution.

At the Seward prospect, two of four holes drilled intercepted gold-bearing structures 1,900 feet below the surface. The Orval Shear, a major regional structural control, was intercepted in the two holes where veins were not encountered, indicating the vein may have been offset by a shear, or structural discontinuity.

Palmer project

The Palmer VMS advanced-exploration-stage project near Haines is being explored by partners

Photo 20.

New high-grade gold-vein target "Elmira" at the Kensington deposit in southeastern Alaska. Photo courtesy of Melanie Werdon, DGGs.



Constantine Metal Resources Ltd. (operator; 51 percent interest) and Dowa Metals & Mining Alaska Ltd. (49 percent interest). The Palmer property occurs within the same belt of rocks that host Greens Creek mine—one of the world's richest VMS deposits. At year-end 2018, the partners updated the project's resource estimates: the combined indicated and inferred resource for the South Wall–RW Zone deposit and the new AG Zone discovery is estimated at 15,731,000 tons grading 0.9 percent copper, 5.04 percent zinc, 26.4 percent barite, 1.65 ounces of silver per ton, and 0.011 ounce of gold per ton (appendix D).

In August 2018, Constantine reported results of a metallurgical test program to determine if a barite concentrate can be produced as a co-product along with copper and zinc concentrates. Work included barite flotation to determine recovery and purity, as well as new copper/zinc flotation and preliminary abrasion/grindability testing; using approximately 429.9 pounds of coarse-reject material from drill holes CMR17-82 and CMR17-97 completed at South Wall in 2017. Highlights of barite test results include: barite recovery of 91.1 percent to a clean, high-grade barite concentrate with a specific gravity of 4.44; produced barite concentrate meets all specifications for oilfield drilling grade barite, including specific gravity, particle size, and purity; and a simple flowsheet with barite recovered by flotation from the tails of copper and zinc flotation. Highlights of copper–zinc test results include: zinc recovery of 93.1 percent to a concentrate grading 61.3 percent zinc; copper recoveries of 88.9 percent to a concentrate grading 24.5 percent copper; combined total silver and gold recovery into copper and zinc concentrates of 90.6 percent and 69.6 percent, respectively, the large majority of which reports to the copper concentrate; and grindability tests indicate a low Bond Work Index of 5.7 kilowatt-hours per ton, which is considered very soft and indicates that grinding cost and power consumption will be low. A barite market study, completed in 2018, supports the potential economics of recovering barite as a saleable commodity.

Constantine's 2018 drill program had a dual focus of exploring for new deposits while also systematically defining and expanding the South Wall and RW Zone mineral resources (photo 21). The Palmer project drill program totaled 29 holes for 34,003 feet. Sixteen holes for 18,950 feet were completed at the AG Zone, with the rest divided between: resource and exploration drilling within the South Wall area (seven holes; 9,259 feet); reconnaissance drilling at the Boundary prospect (four holes; 4,495 feet); and geotechnical drilling to support future underground exploration (two holes; 1,312 feet). South Wall drilling tested the western extension of the zone. Hole CMR18-108 intersected 50.9 feet grading 1.61 percent copper and 4.76 percent zinc. The results expand the zone to the west and confirm continuity of grade and width to the west and down-plunge toward the deeper South Wall EM zone.

New drilling at AG Zone intersected precious- and base-metal-rich, massive barite–sulfide mineralization in multiple drill holes and extends the known strike length to more than 1,804 feet. Drill hole highlights include: CMR18-125 with 45.9 feet grading 4.760 ounces of silver per ton, 0.015 ounce of gold per ton, 5.6 percent zinc, 1.0 percent lead, and 60.7 percent barite; CMR18-128 with 22.3 feet grading 7.212 ounces of silver per ton, 0.023 ounce of gold per ton, 5.5 percent zinc, 2.8 percent lead, and 69.6 percent barite, as well as 112.9 feet grading 4.438 ounces of silver per ton, 0.012 ounce of gold per ton, 1.6 percent zinc, 0.5 percent lead, and 63.6 percent barite; CMR18-130 with 109.9 feet grading 2.862 ounces of silver per ton, 0.012 ounce of gold per ton, 5.0 percent zinc, 1.1 percent lead, 0.2 percent copper, and 41.5 percent barite; and CMR18-132 with 47.2 feet grading 0.672 ounce of silver per ton, 0.006 ounce of gold per ton, 5.5 percent zinc, 0.2 percent lead, and 0.4 percent copper.

Bokan Mountain

During 2018, Ucore Rare Metals Inc. did not conduct field-based exploration work on their Bokan Mountain rare-earth-element (REE)



Photo 21. Constantine Metal Resources Ltd. conducted drilling at their Palmer project near Haines. Photo courtesy of Joe Kurtak.

property in southeast Alaska. However, in January 2018, Ucore stated it selected Ketchikan as the site of its future envisioned Strategic Metals Complex that would potentially serve as the separation plant for REEs mined from the Bokan project. Throughout 2018, preliminary discussions were held with local officials, land options were evaluated, engineering firms were consulted regarding engineering and planning studies, and discussions were held with AIDEA.

Herbert Gold

Grande Portage Resources Ltd. conducted a lidar survey, metallurgical testing, diamond drilling, and a surface exploration program in 2018 at its Herbert Gold project; an orogenic/mesothermal gold-vein system north of Juneau (photo 22). In May 2018, Grand Portage updated Herbert Gold's indicated and inferred resources that now total 1,686,534 tons grading 0.202 ounce of gold per ton for 340,100 ounces of contained gold, based on a 0.073 ounce of gold per ton cut-off grade, 139 diamond drill holes totaling 72,473 feet, and four trenches (appendix D). From northwest to southeast, the primary Herbert Gold vein structures include the North Vein, Goat Vein, Ridge Vein, Main Vein, F Vein, Deep Trench Vein, and Floyd Vein. Sixteen new lineaments, which are sub-parallel to parallel to existing vein structures, were identified in lidar data and will be used to target future drilling.

Two true-width channel samples were collected perpendicular to strike on Goat Vein. Channel sample 54524 graded 3.76 ounces of gold per ton and 1.98 ounces of silver per ton over 3.7 feet, and channel sample 54525 graded 8.46 ounces of gold per ton and 6.53 ounces of silver per ton over 3.3 feet. Metallurgical studies on channel sample 54524 and PQ-size drill sample 339807 from the Deep Trench Vein indicate combined gravity-plus-flotation gold recoveries of 99.5 and 97.7 percent, and silver recoveries of 98.7 and 90.6 percent, respectively; as well as whole-ore cyanidation gold recoveries of 99.6 and 98.4 percent, and silver recoveries of 94.4 and 81.5 percent, respectively.

Grande Portage drilled 15 NQ-diameter diamond drill holes totaling 15,588 feet and two PQ-diameter holes totaling 397 feet from two drill pads in 2018. Exploratory holes 18M-1 and 18M-2 targeted the North Vein and cut multiple visible gold-bearing strands with intercepts up to 0.812 ounce of gold per ton. The majority of the company's drilling was focused on the Goat Vein (holes 18M-3 through 18M-13). Drill hole 18M-12 intersected the main Goat Vein at a depth of 754.6 feet and cut a 20.9-foot interval grading 0.712 ounce of gold per ton. Within this interval, one 2.6-foot sample graded 5.64 ounces of gold per ton. The vein consists of highly sheared, fractured, and hydrothermally altered quartz diorite with disseminated arsenopyrite, local broken quartz, and very fine-grained galena, pyrite, sphalerite, and visible gold. Hole 18M-12 also intercepted a hanging wall satellite vein about 230 feet above Goat Vein, with a 7.1-foot interval grading 0.75 ounce of gold per ton. Hole 18M-6 intersected 20.6 feet grading 0.458 ounce of gold per ton. Contained within this zone is a 3.4-foot, true-width section grading 1.874 ounces of gold per ton near the footwall contact of the structure.

Seven of the eleven holes, drilled in southerly directions and at various azimuths from M Pad, hit shallow mineralization, which is considered by Grande Portage to be a new vein discovery. Hole 18M-10 encountered 27.6 feet grading

0.048 ounce of gold per ton, and hole 18M-13 intersected 15.2 feet grading 0.110 ounce of gold per ton. Holes 18S-1 and 18S-2 targeted the Deep Trench Vein: hole 18S-1 intersected 9.2 feet of 0.460 ounce of gold per ton, and hole 18S-2 intersected 29.8 feet of 0.883 ounce of gold per ton in a quartz vein with visible gold.

Zarembo

The Zarembo Island property, 15 miles west of Wrangell, contains widespread lead–zinc–silver–gold anomalies, and the Frenchie prospect has mineralogical similarities to, and is hosted by, the Late Triassic Hyd Group; which also hosts the Greens Creek mine's VMS deposit to the north. The sulfide zone at the Frenchie prospect contains an eight-foot-thick section of semi-massive sulfide grading up to 4.8 percent zinc, 1 percent lead, and 0.058 ounce of gold per ton. West of the main Frenchie exposure, a three-foot-thick section of altered argillite or tuff near the base of the sulfide zone grades 0.32 ounce of gold per ton and overlies a distinctive muscovite phyllite. The surface exposure of mineralized rock consists of 16.5 feet containing 0.127 ounce of gold per ton. In 2018 Zarembo Minerals Co. LLC conducted a small exploration program.

Niblack

Heatherdale Resources Ltd.'s advanced-exploration-stage Niblack project, a copper–gold–zinc–silver VMS deposit 27 miles southwest of Ketchikan, has indicated and inferred resources totaling 9.955 million tons of material grading 0.81 percent copper (178.78 million pounds), 1.29 percent zinc (311.35 million pounds), 0.039 ounce of gold per ton (384,000 ounces), and 0.59 ounce of silver per ton (5,843,000 ounces; appendix D). In 2018 Heatherdale collected rock samples for geochemical analysis.

Helm Bay

Agnico Eagle (USA) Limited conducted surface exploration activities on their Helm Bay lode-gold property on the Cleveland Peninsula, including geologic mapping, geochemical sampling of bedrock and soils, and geophysical surveys.



Photo 22. Grande Portage's Herbert Gold property north of Juneau hosts six parallel high-grade gold-bearing vein structures exposed at the surface; last accessed September 21, 2019; www.grandeportage.com/photo-gallery/herbert-gold-juneau-gold-belt-alaska/.

Crest

Decade Resources Ltd. staked 19 claims totaling about 390 acres surrounding the Crest gold-bearing quartz vein prospect near Hyder in southeast Alaska. The Crest property lies at the western edge of the “Golden Triangle” of north-western British Columbia and is 4.3 miles south of the Premier gold mine. The area is underlain by the Texas Creek Batholith, a multi-phase Jurassic (193–195 Ma) intrusion, which elsewhere in British Columbia is associated with gold-vein and porphyry copper–gold mineralization. In December 2018, Decade Resources conducted reconnaissance sampling in stream beds along Granduc Road, which crosses the property. A total of five silt samples and 12 iron oxide-stained float rocks in stream beds were collected. Silt samples contained up to 0.007 ounce of gold per ton. Rock float samples yielded high gold and silver values (up to 59.39 ounces of gold per ton and up to 17.49 ounces of silver per ton) and were variably anomalous in arsenic, lead, and zinc.

Alaska Peninsula Region

Unga project

Redstar Gold Corporation's Unga project includes the Apollo mine, and Shumagin,

Centennial, Orange Mountain, Zachary Bay, Amethyst, and Aquila epithermal gold–silver prospects. Results from their extensive 2017 drilling, geologic mapping, prospecting, and ground-based geophysical surveying program were used to complete an updated NI 43-101 Unga project report in 2018, and to evaluate how best to advance the project.

Pyramid

The Pyramid project is an early-stage porphyry copper–molybdenum–gold exploration project, located on Aleut Native Corporation land on the Alaska Peninsula. This project is being explored by CopperBank Resources Corp. In 2018 CopperBank released an updated inferred mineral resource that incorporated the 12,008 feet drilled during 2017, along with prior drilling, for a total of 34,777 feet drilled at the Pyramid project. The updated inferred mineral resource estimate, using a 0.2 percent copper-equivalent cut off, is 169.1 million tons at 0.37 percent copper, 0.021 percent molybdenum, and 0.003 ounce of gold per ton (appendix D).

In early 2018, Auracle Geospatial Science Inc. provided CopperBank with a 3D Radar Model defining surface and near-surface structures over the Pyramid and San Diego Bay properties, which total 97 square miles. Auracle

extracted strike and dip measurements of the different interpreted structures, and produced a series of maps including apparent resistivity, digital elevation model, and structure analysis. The zones of high fracturing are of particular interest as they may reflect ground preparation to mineralization and possible underlying intrusions.

San Diego Bay

The San Diego Bay project, located 6.2 miles west of the Pyramid porphyry copper deposit on the Alaska Peninsula, is a joint-venture project on a 100 percent basis between CopperBank Resources Corp. and the Aleut Corporation, an Alaska Native corporation that controls the subsurface mineral rights. The San Diego Bay project covers a 15-square-mile area with strong hydrothermal alteration and intrusive rocks (photo 23). Porphyry alteration facies observed include potassic, advanced argillic, and phyllic zones. In August 2017, CopperBank conducted a selective, reconnaissance prospecting and soil sampling program to test historical copper and gold anomalies over the San Diego Bay, Renshaw Point, and Balboa Bay areas. Results from the 2017 sampling program were used to complete a San Diego Bay project NI 43-101 technical report in 2018, which recommends further exploration steps.

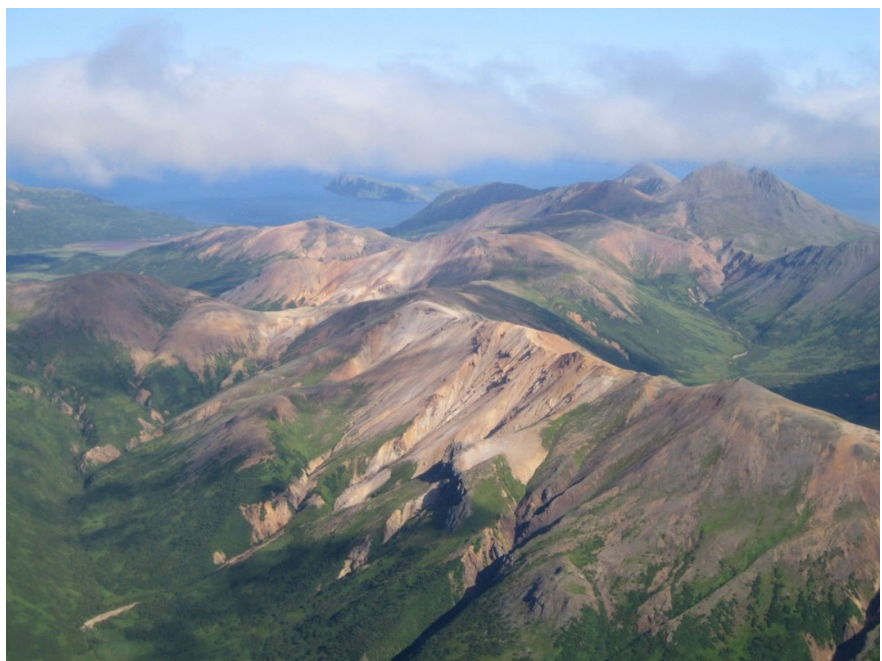


Photo 23. CopperBank Resources Corp.'s San Diego Bay porphyry deposit on the Alaska Peninsula is hosted by a 15-square-mile area of gossan, strong hydrothermal alteration, and intrusive rocks, similar to the adjacent Pyramid deposit. Photo source: CopperBank Resources Corp.; last accessed September 21, 2019; www.copperbankcorp.com/projects/alaska-projects/san-diego-bay-project/.

DEVELOPMENT AND PRODUCTION

Alaska's mines continued to invest in the future, as indicated by increased development expenditures, modest minesite exploration, and efforts to identify additional near-site resources to feed established mills. Development in 2018 increased by almost 12 percent to \$334.1 million—a high not seen since 2013. Eight projects that reported significant development expenditures are shown in figure 8: Red Dog, Fort Knox, Pogo, Kensington, and Greens Creek mines together spent more than \$329.0 million, almost 99 percent of the total. This report includes expenditures of permitting-stage projects in the exploration sector. Precious-metals projects comprised 47 percent of the development expenditures in 2018 (table 9).

Lower production for most metals, volatile metal prices, and a strong U.S. dollar in the

second half of 2018 allowed revenues to drop almost 11 percent, according to proprietary revenue values reported by the mines (tables 1 and 10). This scenario was consistent throughout the U.S., where the estimated nationwide value of metal mine production (including iron) decreased by four percent to \$25.9 billion.⁷ In contrast, the estimated value of mineral production in Alaska for 2018, including theoretical first market values substituted for confidential data, increased less than one percent (\$3.2 billion; table 11).

Zinc remains the State's leading mineral product, with an estimated production value of \$1.90 billion in 2018 (a 16 percent increase from 2017; table 11). Zinc accounted for more than half of Alaska's metal production value (figure 9). The annual value of zinc production has exceeded that of gold since 2014 (appendix

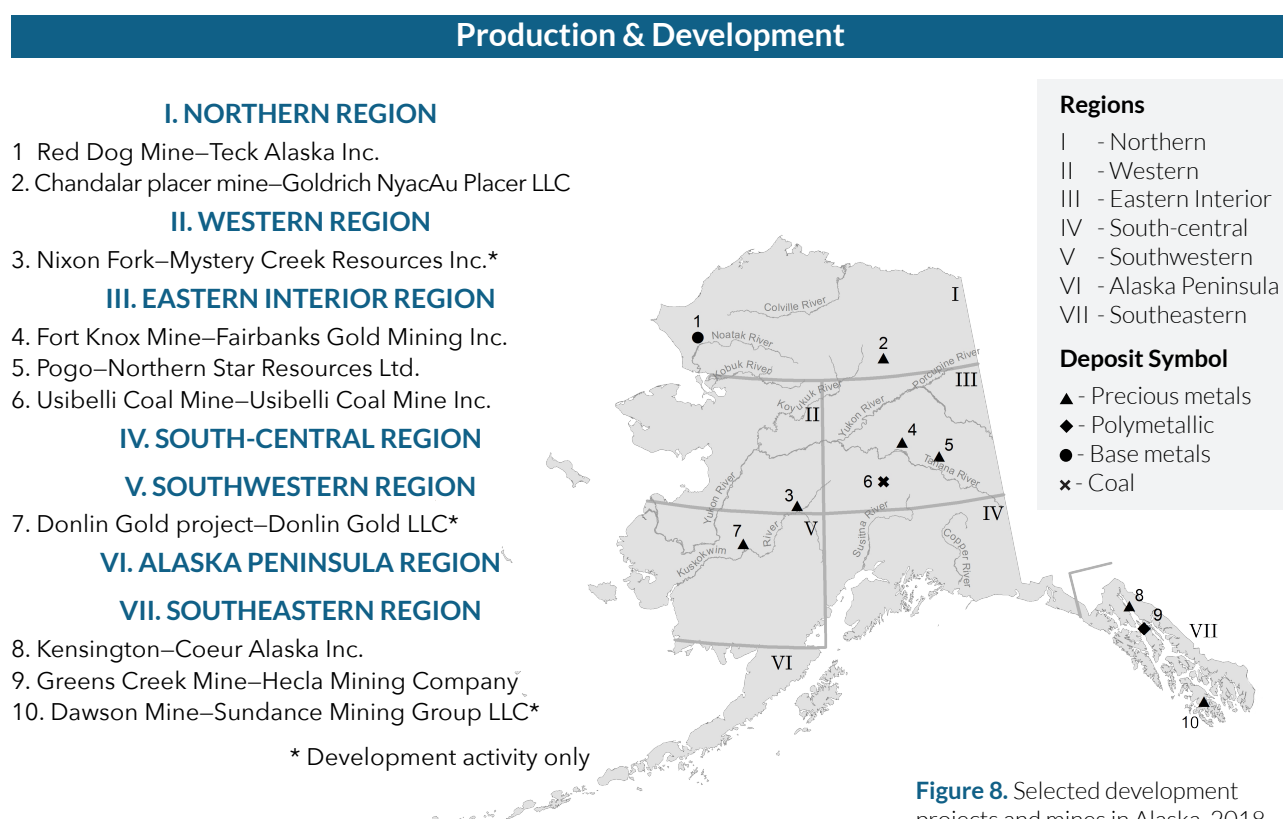


Figure 8. Selected development projects and mines in Alaska, 2018.

⁷U.S. Geological Survey, 2019, Mineral commodity summaries 2019: U.S. Geological Survey, 200 p. doi.org/10.3133/70202434

Table 9. Reported mineral development expenditures in Alaska by commodity, 1982–2018.

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
Total	\$ 1,096,081,545	\$ 695,823,514	\$ 4,313,102,315	\$ 1,670,250	\$ 42,749,261	\$ 120,511,544	\$ 6,736,656,418

^aPolymetallics category added in 1986.^bGemstone development category added in 2009.^cSignificant 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.

B). The value of gold production has decreased 43 percent to \$0.89 billion in 2018 from 2013's record value of \$1.55 billion.

Gold production from lode mines in the Eastern Interior and Southeastern regions totaled 651,295 ounces in 2018, of which nearly three-quarters was produced from the Fort Knox and Pogo gold mines in the Eastern Interior region (figure 10). Kensington gold and Greens Creek polymetallic mines in southeastern Alaska, the third and fourth largest gold producers, accounted for the remainder of lode gold production. Placer gold production in 2018 is estimated to be 60,691 ounces; almost nine percent of the total gold produced in Alaska (table 12).

Employment related to gold production in 2018 is 1,324 full-time-equivalent jobs; more than 38 percent of mining jobs in all sectors (table 2; photo 24).

The value of Alaska industrial minerals (rock, sand, and gravel) is at least \$10.5 million in 2018. 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 (figure 11; appendix C). The total estimated volume of industrial minerals sold in the state is 4.0 million tons (including data from all three DNR land offices; table 13), of which the Northern region accounted for 93

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

Table 10.
Average metal
prices, 1996–2018.

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

^a 2009–2018 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 2013–2018 copper, lead, and zinc prices from U.S. Geological Survey Mineral Commodity Summaries, based on London Metal Exchange (LME), and LME average daily settlement.

percent. The 2018 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 2018 export value was \$1.78 billion for ores, concentrates, and other mining products shipped from Alaska, down almost 1.5 percent from 2017 (table 14). 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 2018 (figure 12).

Development and production estimates in this report are compiled from a variety of online

sources: annual reports, 10-K reports, and news 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,

Table 11. Estimated mineral production in Alaska, 2016–2018.^a 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 or export values that are actual sales.

Metals	Production Volume			Production value (\$)		
	2016	2017	2018	2016	2017	2018
Gold (ounces)	909,242	859,631	711,986	\$ 1,119,280,480	\$ 1,064,039,938	\$ 888,302,130
Silver (ounces)	16,621,035	16,085,142	15,116,355	246,109,759	245,911,320	210,826,760
Lead (tons)	155,409	140,683	127,427	241,931,352	279,092,676	252,176,360
Zinc (tons)	700,376	649,889	698,218	1,250,186,440	1,595,551,564	1,851,779,320
Subtotal	--	--		\$2,857,508,031	\$3,184,595,498	\$3,203,084,570
Industrial Minerals						
Sand and gravel (million tons) ^b	6.1	3.9	4.0	\$17,258,291	\$11,633,541	\$10,531,812
Rock (million tons)	--	--	--	--	--	--
Subtotal				\$17,258,291	\$11,633,541	\$10,531,812
Coal and Peat						
Coal (tons) ^c	930,987	873,000	1,000,000	\$32,584,545	\$30,555,000	\$35,000,000
Peat (cubic yards) ^c	--	--	--	--	--	--
Subtotal				\$32,584,545	\$30,555,000	\$35,000,000
Total				\$2,907,350,867	\$3,226,784,039	\$3,248,616,382

^aProduction data from DGGs questionnaires, Internet research, interviews with operators, DOT&PF, and municipalities, regional corporations, and Federal land management agencies.

^bIndustrial minerals (rock, sand, and gravel) values are combined into the sand and gravel category in 2016–2018.

^cCoal and peat production values are combined in 2016–2018.

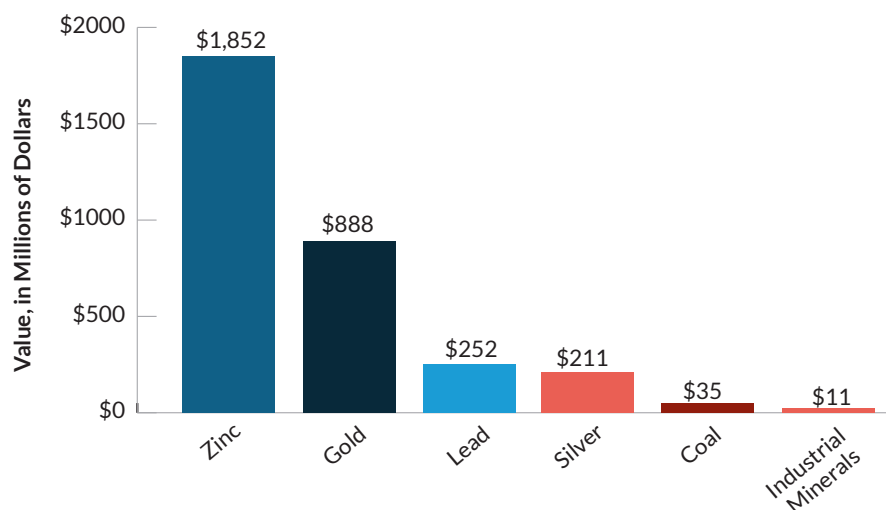


Figure 9.
Estimated 2018
mineral production
in Alaska by
commodity.

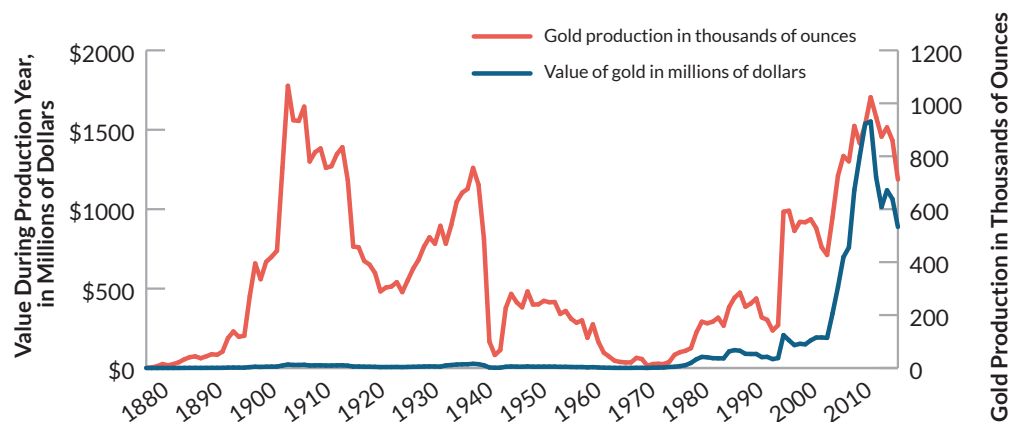


Figure 10.
Historical gold
production
in Alaska,
1880–2018, and
corresponding
market value.

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 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 10). 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 northwest Alaska is one of the world's largest sediment-hosted massive

Table 12. Production and employment estimates for Alaska placer gold mines, 2013–2018. Note yearly values reported by the Department of Revenue were adjusted to align with the production year and calculated values were subsequently revised. Values for 2018 (italics) are estimated by the DGGs authors based on reported placer data for 2017.

	2013	2014	2015	2016	2017	2018 estimates
Number of placer operations reporting gross operating income ^a	229	238	236	205	192	192
Total gross operating income reported ^a	\$104,994,998	\$78,200,155	\$64,803,637	\$51,912,476	\$76,985,791	\$76,985,791
Average yearly price of gold ^b	\$1,411.23	\$1,266.40	\$1,160.06	\$1,250.74	\$1,257.12	\$1,268.49
Estimated number of gold ounces produced	74,400	61,750	55,862	41,505	61,240	60,691
Estimated number of full-time-equivalent employees	216	224	222	193	181	181

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, www.dropbox.com/s/wly4yrnmlop59on/AMA%20Placer%20Final%20Report%2011.15.pdf?dl=0.

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.

^a2013–2017 values provided by the Department of Revenue.

^b2013–2018 gold prices from Kitco cumulative average London PM fix.

Photo 24.

Small trommel at the Eureka placer mine in the Hot Springs Mining District. The operators have pioneered a new technique for working in a tight valley. They move their tailings uphill and spread the material downslope along the contour of the valley, turning them into elongated holding ponds. These are later reclaimed by moving the material back downhill to fill their pit. This method uses good water-management practices and provides an efficient means of reclamation and tailings storage. Photo courtesy of Aaron Kruse, DMLW.



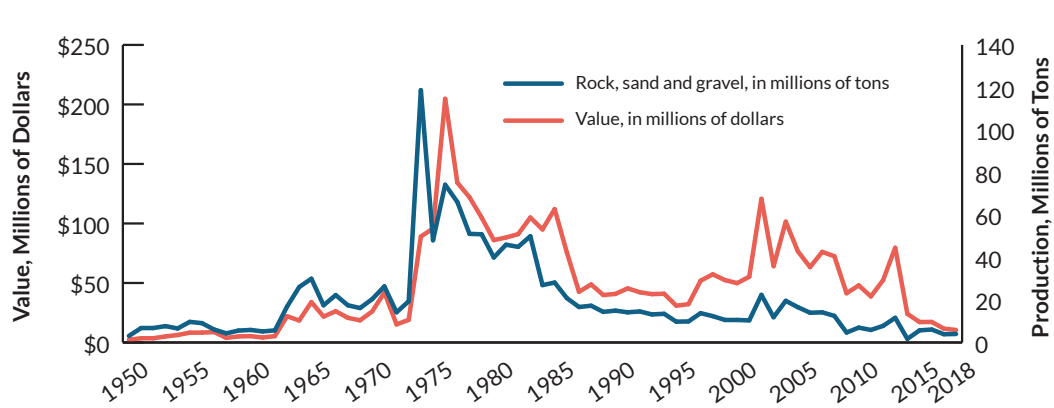


Figure 11. Rock, sand, and gravel production in Alaska, 1950–2018.

Table 13. 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 2011–2018. 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
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
South-Central (Anchorage office)	70,410	1,035,450	235,050	433,433	2,115,750	396,657	396,657	143,597
Southeast (Juneau office)	77,940	56,115	69,866	62,559	50,211	13,268	13,268	30,173
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

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.

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. Teck Alaska leases the road and port facilities from AIDEA (photo 25).

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 2018 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 for the next nine years.

In 2018 Red Dog zinc production increased to 642,868 tons compared to 597,342 tons in 2017; primarily due to higher zinc grades and recoveries (table 15). The zinc grade was 15.7 percent, with an 83.9 percent recovery rate. Lead production in 2018 declined to 108,467 tons, compared to 122,687 tons in 2017; primarily due to lower grades and recoveries. The lead grade was 4.4 percent with a 50.2 percent recovery rate. In 2018 Teck Alaska employed approximately 700 full-time staff (including contractors), mined

Table 14. 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

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

^aHS 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.

^bValue of Canada copper ores moving through Skagway that are included in Mineral Ores and Concentrates values

^cHS 71 Precious Metals: Gold doré, precious stones, and wrought jewelry

^dHS 27 Coal

12,642,400 tons of material, milled 4,882,100 tons of material, and sold 1.149 billion pounds of zinc and 209.66 million pounds of lead.

Teck's gross profit at Red Dog before depreciation and amortization in 2018 was \$990 million, compared with \$971 million in 2017. Gross profit in 2018 was \$864 million; close to the 2017 values, as sales volumes and metal prices were also similar. Sustaining capital investments were \$65 million at Red Dog operations. Work continued on the \$110 million mill upgrade project, which is progressing as planned. 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 remain unchanged through 2031.

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

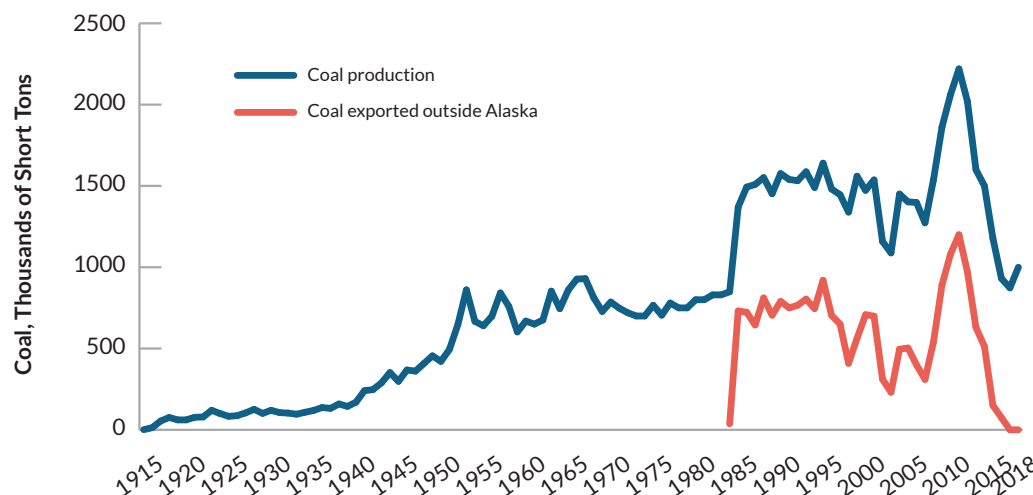


Figure 12.
Alaska coal
production and
exports, 1915–
2018.

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 2018 was \$252 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. The open-pit and truck-and-shovel operation uses carbon-in-pulp, heap leach, and gravity processes to recover gold. Fort Knox production for 2018 totaled 255,569 gold-equivalent ounces. At Fort Knox, reduced production was largely due to a decrease in grades and tons of ore processed in the mill and placed on the heap leach pads. A pit-wall failure in the first quarter of 2018 also limited access to higher-grade ore, and higher-than-average rainfall in the second half of 2018 affected geotechnical stability.

Fort Knox's 2018 production cost of sales was \$214.4 million, and \$837 per equivalent ounce of gold sold. Full-year cost of sales per ounce was higher compared with 2017 mainly due to a decline in grades and an increase

in operating waste mined. In 2018 Kinross employed an average of about 630 people, mined 71.9 million tons of material, processed 12,996,250 tons of ore through the mill, and processed 17,975,390 tons of ore on the heap leach pad at Fort Knox (table 16). Mill grade averaged 0.016 ounce of gold per ton with an 82 percent recovery rate; the heap leach grade averaged 0.006 ounce of gold per ton. Capital expenditures were \$89.5 million, and depreciation, depletion, and amortization expenses totaled \$109.7 million.

**Congratulations
to Fort Knox. They've
now surpassed one
billion tons of ore
and waste material
mined.**

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. This estimate is based on an initial 239,500-foot, 205-hole drilling program in 2014 on Gilmore land, and on Fort Knox land adjacent to Gilmore. Fort Knox

Photo 25.

Teck Alaska Inc.'s red and white Concentrate Storage Buildings at the Red Dog port facilities, with barges in the Chukchi Sea in the background. Photo courtesy of William Groom, DMLW.



mine reserves and resources as of December 31, 2018 are tabulated in appendix D.

In June 2018, Kinross completed a feasibility study of the \$100 million Gilmore expansion of the Fort Knox open pit. Kinross also released an NI 43-101 technical report for Fort Knox mine and their Gil project about 8 miles to the northeast. This report describes the current mining operation as well the extended life of mine including Gilmore; this extension project is on schedule, with stripping expected to commence in late 2019. 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. In August 2018, Northern Star Resources Limited announced that they agreed to acquire the high-grade Pogo gold mine for \$260M from joint-venture owners Sumitomo Metal Mining Co., Ltd and Sumitomo Corporation. This equates to an acquisition price of \$63 per ounce of gold based on Pogo's non-JORC-compliant reserves and resources at the time of purchase. Northern Star assumed management control of the Pogo operation on September 28, 2018. Since then, Northern Star

implemented a range of operational changes, many of which involve increasing the scale of mining activity and the number of work areas. In October, all 10-foot by 10-foot development was converted to 15-foot by 15-foot, which limited impact to mined grade but generated an increase of more than 30 percent in productivity and reduced operating costs per ton. Increasing the ore-heading size also allowed 17 pieces of mobile equipment to be parked out of 55; a 31 percent reduction. The number of available ore headings was doubled with over 20 new work areas identified. Many of these headings are in areas where the capital infrastructure is already in place; therefore, costs are low to access and the timeframe to production is minimal. Mining-method changes are in progress to bring in a much larger percentage of long-hole stoping, which will lower costs and enable a higher percentage of ore extraction. Northern Star had 340 employees and more than 200 contract employees in 2018, and ore was sourced from the Liese, East Deep, North, and Fun zones (table 17). Pogo mine produced 227,901 ounces of gold from 880,075 tons of ore milled. The mine moved 1,531,890 tons of ore and waste materials and placed 11,585,806 cubic feet of paste fill back in the underground workings (photo 26).

Total JORC-compliant indicated and inferred resources for Pogo mine as of June 30, 2018, inclusive of reserves, are estimated at 9.692

Table 15. Red Dog mine production statistics, 1989–2018.^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
Total	95,884,583				32,340,345	14,989,579	2,812,276	161.82	

^aRevised slightly from Special Report 51, Alaska's Mineral Industry 1995, based on new company data.

^bTotals for years 1990 through 1995 include bulk concentrate. Total for 2013 estimated from total metal produced for 2013.

^cEstimate 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 and 2017; 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.

^dIncludes contract employees, if known.

-- = No concentrate produced

NA = Not available

Table 16. Fort Knox mine production statistics, 1996–2018.

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
Total	1,018,767,340	36,379,500	1,055,146,840	310,294,743	11,036,722	321,331,465	233,039,907	7,870,768	

^aTrue North Mine started production in 2001 and suspended production in 2004.^bWalter 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.

million tons grading 0.471 ounce of gold per ton for 4.15 million ounces of gold (appendix D). All indicated and inferred material reported within the current resource is spatially located within 1,640 feet of existing mine operations. The resource consists of extensions to currently mined mineralized structures, coherent mineralized structures parallel to the Liese system, and remnant material not extracted during first-pass mining. The new JORC estimate included a 24 percent increase in the in-mine resource over the prior estimate; it does not include an additional 765,000 ounces of gold in non-JORC-compliant resources contained in satellite deposits.

Usibelli Mine

Usibelli Coal Mine Inc. is a local, family-owned coal mining company in production since 1943 with an average of 100 full-time-equivalent employees in 2018. 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

Table 17. Pogo mine production statistics, 2006–2018.

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
Total	12,183,998	10,193,485	3,866,295			

^aIncludes contract employees, if known.

^bSilver production of 32,000 ounces was reported in 2013.

^cValues are underreported due to the change in ownership to Northern Star Resources in 2018.

-- = Not reported

Photo 26. View of the dry-stack tailings at the Pogo mine in interior Alaska. Photo from: Northern Star Resources Limited, September 27, 2018, Pogo gold mine site visit (presentation); last accessed October 4, 2018; www.nsrlltd.com/wp-content/uploads/2018/09/Pogo-Site-Visit-Presentation-27-09-2018.pdf.



coal. Poker Flats, now fully reclaimed, produced about 27 million tons of coal beginning in the 1970s. All coal is subbituminous, low-ash, and extremely low in sulfur content.

Usibelli Coal Mine celebrated its 75th anniversary in 2018. The mine delivered its first 10,000 tons of coal to the U.S. Army in Fairbanks in 1943. In 1971, six years before it was required by federal law, the mine pioneered successful reclamation including the now-standard process of re-contouring and reseeding disturbed areas with a mixture of grasses and indigenous plants. Since 1971, over 5,500 acres of land have been reclaimed. In 2017 the mine reclamation team planted more than 25,000 trees and seeded 138 acres for final reclamation. The mine recently completed a haul road to access the new Jumbo Dome mining area. This road provides access to 83 million tons of permitted coal, which supplies the operation with a more than 100-year mine-life at current production levels.

In 2018 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 is in the process of commissioning a new boiler and 17-megawatt turbine generator, Eielson Air Force Base is upgrading multiple boilers. Golden Valley Electric Association is in the process of commissioning the Healy Number 2 power plant, a 50-megawatt coal-fired

electrical plant at the mouth of the Usibelli mine, which is projected to use about 200,000 tons of coal per year.

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 is recovered using flotation processes. Kensington mine reserves and resources as of December 31, 2018 are tabulated in appendix D.

Coeur Alaska, Inc. employed 410 full-time employees and contractors in 2018; and 641,058 tons of material were processed through their mill at an average grade of 0.18 ounce of gold per ton with an average 92.3 percent recovery rate (table 18). Full-year production was 105,570 ounces of gold; an additional 8,208 ounces of gold was sourced from the Jualin deposit prior to declaring commercial production in December 2018. Including this pre-commercial production, full-year gold production totaled 113,778 ounces; slightly lower than in 2017. The following quantities exclude pre-commercial production from Jualin. Coeur sold 106,555 ounces of gold for

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
Total	4,763,605			928,400

Table 18.
Kensington
mine production
statistics,
2010–2018.

^aProduction started July 3, 2010.

metal sales of \$132.9 million. Costs applicable to sales were \$112.4 million, adjusted average cash costs applicable to sales for the year were \$1,050 per ounce of gold, and total sustaining and development capital expenditures were \$42.7 million.

Network infrastructure was designed, developed, and installed to support remote and autonomous mucking in various stopes of the Kensington deposits. Phase 3 of the tailings dam raise was put into service in December 2018. Work on the new power house neared completion, and commissioning is planned in early 2019.

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 (photo 27). 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.

In 2018 Hecla produced 7,953,003 ounces of silver; a decrease of five percent compared to 2017 (table 19). Gold production in 2018 was 51,493 ounces; an increase of one percent from 2017. The decrease in silver production resulted

from lower grades. Gold production was modestly higher due to higher throughput, which was a record for the company. The mine also yielded 18,960 tons of lead and 55,350 tons of zinc. The mill operated at an average of 2,316 tons per day for the year, for a total of 845,398 tons of ore processed. Mining and milling costs per ton were \$71.37 and \$33.53, respectively. Ore grades milled were 12.16 ounces of silver per ton, 0.09 ounce of gold per ton, 2.80 percent lead, and 7.47 percent zinc. The cost of sales and other direct production costs and depreciation, depletion, and amortization for 2018 was \$190,066,000; a decrease of six percent over that of 2017. The total cash cost, after byproduct credits, was \$1.13 per ounce of silver; a decrease from \$0.71 for 2017. The decrease in cash cost, after by-product credits, per silver ounce for 2018 was due to higher by-product credits. The all-in sustaining capital (AISC), after byproduct credits, was \$5.58 per ounce of silver. The impact of higher by-product credits on AISC, after by-product credits, was partially offset by higher capital spending for the full year of 2018. For the full year of 2018, Greens Creek generated cash provided by operating activities of approximately \$125.1 million and spent \$40.8 million on capital additions to properties, plants, and equipment, resulting in free cash flow of \$84.3 million. Hecla had 426 full-time employees at Greens Creek in 2018.

Photo 27.

Underground mining at Hecla Mining Company's Greens Creek mine in southeast Alaska. Photo source: Hecla Mining Company; last accessed September 21, 2019, www.hecla-mining.com/wp-content/uploads/2015/11/Hecla-GreensCreek-13-Hecla-2576a.jpg.



Definition drilling at Greens Creek in 2018 focused on upgrading mineralized material to reserves at the East Ore, 9A, Northwest West, Deep Southwest, West, Upper Plate, Gallagher and Deep 200 South zones. Ore tonnage, as well as silver and gold ounces and tons of zinc and lead in the reserve, experienced a notable increase driven by high-grade definition and exploration drill results, the new net smelter-return terms (improved by-product credits and payable portions for zinc and gold), and new resource modeling techniques, as well as various design changes made to reduce dilution. Greens Creek mine reserves and resources as of December 31, 2018, are tabulated in appendix D. Based on these estimates of reserves and mineralized material, the currently expected remaining mine life at Greens Creek is approximately 11 years.

Chandalar Mine

The Chandalar placer mine in the southern Brooks Range near the Dalton highway is owned by Goldrich NyacAU Placer, LLC, a joint venture formed between Goldrich Mining Company and project manager NyacAU to mine the various placer deposits that occur throughout Goldrich's

23,000-acre Chandalar gold project. Production for 2018 was 20,900 ounces of alluvial placer gold for 17,100 ounces of fine gold. The 2018 production season ran from about May 31 through mid-September.

Donlin Gold Project

Donlin is a proposed, large open-pit gold mine located in southwest Alaska. Donlin is owned by Donlin Gold, LLC, a 50/50 partnership between Barrick Gold Corp. and NovaGold Resources Inc. With permitting nearly completed as of year-end 2018, there is an increased focus on continuing to integrate scoping-level optimization work into an upcoming feasibility study that will serve as the basis for an updated optimized project development plan. The total advanced-stage exploration and development budget for the Donlin Gold project for 2018 was \$22 million, which was included as exploration funds for 2018. See page 41 for additional information on this project.

Nixon Fork Mine

The Nixon Fork underground mine is a copper–gold skarn deposit located 32 miles

Table 19. Greens Creek mine production statistics, 1989–2018.

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
Total	17,820,624	--	1,730,754	551,236	8,593	1,699,013	228,016,419	

^aNo copper credits in 1989–1993 and 2003–2018.^bPartial-year production.^cNo production in 1994 and 1995 due to mine closure.^dFifteen of these employees were assigned to development effort.^eFifty employees were assigned to development and reported in that section's employment.^fForty-five employees were assigned to development and reported in that section's employment.^gNineteen employees were assigned to development and reported in that section's employment.^hEighty-five employees were assigned to development and reported in that sector's employment.ⁱSeventy-nine employees were assigned to development and reported in that sector's employment.^jNineteen employees were assigned to development and reported in that sector's employment.^kThirty-nine employees were assigned to development and reported in that sector's employment.^lAll employees were assigned to the production sector.

-- = Not reported

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 2018 Mystery Creek continued work to restart the mine.

Dawson Mine

The Dawson mine development project is located on Prince of Wales Island in southeast Alaska, about 3.5 miles from the Hollis ferry terminal. It is being developed by Sundance Mining Group LLC and Alaska Hardrock Inc. The Dawson mine contains 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.

During 2018, Sundance completed Phase II permitting allowing for mill development, production mining, and milling (photo 28). Their continued underground exploration/development program completed approximately 450 feet of rubber-tired drifting on vein, and approximately 480 feet of jackleg/slusher scam up-dip and along strike of the Humboldt vein system. Approximately 4,000 tons of initial mill feed were produced. Underground mining was curtailed during June to focus spending on mill development. Miners were provided the option to leave or to stay and help construct the mill. Mill site development was completed, and a 150-ton-per-day gravity mill was installed. Production mining and milling are planned for startup in 2019.

Photo 28.

Portal of the Dawson high-grade gold-silver mine in southeast Alaska. Photo courtesy of William Groom, DMLW.



DRILLING

Fifteen companies publicly reported significant drilling programs in Alaska in 2018 across all sectors; most respondents kept drilling information confidential (table 20). Total 2018 drilling was 1,039,089 feet, up slightly (2 percent) from 2017 (table 21). Development drilling totaled 402,849 feet, and production drilling totaled 102,602 feet. Drilling programs were reported for 25 individual metal exploration projects; four more projects than in 2017. Exploration drilling totaled 532,138 feet in 2018; 17 percent fewer feet than were drilled in 2017. About 301,136 feet, 57 percent of exploration drilling, was conducted at mine sites to increase reserves and extend mine life; down 13 percent from 2017. Globally, the number of projects that reported drilling activity more than doubled to 1,261 projects in 2018.⁶

Drilling footage was primarily compiled from questionnaires, public company reports, and

online information, and represents a minimum amount for 2018. Production drilling is likely under-reported, and placer exploration drilling in 2018 was not compiled. Blast-hole drilling during production at Alaska's large lode mines was not tracked.

Table 20. Companies publicly reporting significant drilling programs in Alaska in 2018.

Avidian Gold Alaska Inc.	Northern Star Resources Limited
Coeur Alaska Inc.	PolarX Limited
Constantine Metal Resources Ltd.	Teck Alaska Inc.
Freegold Ventures Limited	Trilogy Metals Inc.
Grande Portage Resources Ltd.	Valdez Creek Mining Company LLC
Graphite One Inc.	Western Alaska Copper & Gold Co.
Hecla Greens Creek Mining Company	White Rock Minerals Ltd.
Kinross Gold Corporation	

Table 21. Drilling footage reported or estimated in Alaska, 1982–2018.

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

^aCore 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 – http://dnr.alaska.gov/ssd/recoff/fees_RO.cfm

Public Information Center – <http://dnr.alaska.gov/commis/pic/>

State Uniform Commercial Code (UCC) Documents Search – <http://dnr.alaska.gov/ssd/recoff/ucc>

Division of Mining, Land & Water

Mining Applications and Forms – <http://dnr.alaska.gov/mlw/forms/>

Fact Sheets – <http://dnr.alaska.gov/mlw/factsht/>

Annual Placer Mining Application (APMA) – <http://dnr.alaska.gov/mlw/mining/placer.cfm>

Annual Rental – http://dnr.alaska.gov/mlw/factsht/mine_fs/annualre.pdf

Leasing State Land – http://dnr.alaska.gov/mlw/factsht/land_fs/lease_land.pdf

Land Lease & Contract Payment Information – http://dnr.alaska.gov/mlw/factsht/land_fs/lease_contract_payment_info.pdf

Production Royalty – http://dnr.alaska.gov/mlw/factsht/mine_fs/producti.pdf

DNR Production Royalty Form – http://dnr.alaska.gov/mlw/forms/mining/royalty_fm.pdf

Exploration Incentive Credit Program – http://dnr.alaska.gov/mlw/factsht/mine_fs/explore.pdf

Division of Geological & Geophysical Surveys

Publications On-Line – <http://dggs.alaska.gov/pubs/>

Interactive Maps – <http://maps.dggs.alaska.gov/>

Geologic Maps of Alaska: Online Map Search Tool – <http://maps.dggs.alaska.gov/mapindex/>

Unpublished Geology-Related Data (Alaska Geologic Data Index) – <http://maps.dggs.alaska.gov/agdi/>

Geologic Materials Center – <http://dggs.alaska.gov/gmc/>

Alaska Geochemistry Web Map – <http://maps.dggs.alaska.gov/geochem/>

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

MDIRA Portal Home Page – <http://akgeology.info/>

Alaska Mining Claims Mapper – <http://akmining.info/>

Land Records Web Application – <http://dnr.alaska.gov/Landrecords/>

State Recorder's Office Search – <http://dnr.alaska.gov/ssd/recoff/searchRO.cfm>

Alaska Resource Data Files – <http://ardf.wr.usgs.gov/>

USGS Alaska Geochemical Database, Version 3.0 (NURE, RASS, PLUTO...) – <https://pubs.er.usgs.gov/publication/ds1117>

Guide to Alaska Geologic and Mineral Information – <http://doi.org/10.14509/3318>

Alaska State Geo-Spatial Data Clearinghouse – <http://www.asgdc.state.ak.us/>



DEPARTMENT OF COMMERCE, COMMUNITY, AND ECONOMIC DEVELOPMENT

Minerals Information – <https://www.commerce.alaska.gov/web/ded/dev/mineralsdevelopment>

Community and Regional Information – <https://www.commerce.alaska.gov/web/dcra/ResearchAnalysis>

Alaska Industrial Development and Export Authority (AIDEA) – <http://www.aidea.org>

AIDEA Supports Mining – <http://www.aidea.org/Programs/ProjectDevelopment/33YearsofMiningSupport.aspx>

DEPARTMENT OF REVENUE

Mining License Tax – <http://www.tax.alaska.gov/programs/programs/index.aspx?60610>

Motor Fuel Tax Claim for Refund – <http://www.tax.alaska.gov/programs/programs/forms/index.aspx?60210>

Alaska Motor Fuel Tax Instructions – <http://www.tax.alaska.gov/programs/documentviewer/viewer.aspx?5086f>



APPENDIX B

Primary metals production in Alaska, 1880–2018^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	--	--	--	--	--	--
Other ^e	--	--	--	--	1,438	--	--	--	--	--
Total	49,275,666	\$16,783.0	408,654,646	\$4,586,205.3	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
^aFrom 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.

^bGold production adjusted to be more consistent with mining district production totals.
^c76-lb flask.
^dCrude platinum; total production of refined metal is about 575,000 oz.
^eNot traceable by year

APPENDIX B, CONTINUED

Primary metals production in Alaska, 1880–2018^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	--	--	--	--	--	--
Other ^e	--	--	--	--	71,946	17,091.9	--	--	--	--
Total	3,467,816	\$4,314,836.2	16,630,428	\$25,891,934.5	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
^aFrom 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.

^bGold production adjusted to be more consistent with mining district production totals.
^c76-lb flask.
^dCrude platinum; total production of refined metal is about 575,000 oz.
^eNot traceable by year.

APPENDIX C

Production of industrial minerals, coal, and other commodities in Alaska, 1880–2018^{a,b}

Year	Coal		Sand and Gravel ^c		Rock ^d		Barite		Other ^e
	short tons	m\$	short tons	m\$	short tons	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	--	--	--	--	--
Other	--	--	--	--	2,300,000 ^f	W	79,000	W	--
Total	81,734,311	\$1875.0	1,344,487,907	\$34598	153,410,553	\$952.5	856,000	\$11,417.0	\$196,782,450

^aFrom published and unpublished State and Federal documents. Where State and Federal figures differ significantly, State figures are used.

^bPlease refer to previous editions of this appendix for year-to-year production information for years 1900 to 1979.

^cAs of 2015, rock, sand, and gravel are reported as a combined commodity.

^dBuilding-stone production figures for 1880–1937 are for the southcentral and interior regions of Alaska only.

^eIncludes 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).

^fMarble quarried on Prince of Wales Island, southeastern Alaska (1900–1941).

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

APPENDIX D, CONTINUED

DEPOSIT—Type—Metal Suite

Phase		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
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	1003	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										
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				
RED DOG — Massive sulfide — Base metals (lead, zinc, silver) Source: www.teck.com/investors/reserves-&-resources, accessed on May 21, 2019																						
Production (Aqqaluk, Qanaiyaq)	Probable	61,729,433			3.8	2,358,946	13.1	13,029,320			2.06	76,060										
Production (Aqqaluk, Qanaiyaq)	Indicated	14,219,816			2.9	824,749	8.7	2,474,248			1.56	22,214										
Production (Aqqaluk, Qanaiyaq)	Inferred	8,928,722			4.3	767,870	11.3	2,017,891			2.38	21,275										
Total		84,877,971			3.7	3,951,565	12.2	17,521,459			2.01	119,549										
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										

APPENDIX D, CONTINUED

Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																						
Phase		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 — 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	1,102,311,311														?	?					
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												
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														
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										
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										
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		
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																		
GRAPHITE CREEK — Other — Other (graphite) Source: NI 43-101 Preliminary Economic Analysis on the Graphite One Project; technical report dated June 30, 2017																						
Exploration (6.0% Cg cut-off)	Indicated	11,375,853																			7.2	1,640,239
Exploration (6.0% Cg cut-off)	Inferred	78,528,658																			7.0	10,954,770
Total		89,904,511																			7.0	12,595,009
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. [pubs.usgs.gov/pp/1760/c/]																						
Exploration (min. 4.5M tonnes; possibly >38 M tonnes)	Inferred	4,960,395														93	9,226,335					

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](https://www.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	3,896,314	2,051	3,894,263
44 Fairbanks district	16,423,463	8,282,595	8,140,868

Mining districts ^a	Production (in refined troy ounces)		
	Total	Placer	Lode
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	10,417,224	82,390	10,334,834
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	224,431	221,237	3,194
TOTAL (refined Troy ounces)	49,765,203	25,125,603	24,639,600

(1,548 metric tons)

^aMining 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 1970–2018. Entries of "0" generally mean no specific records are available.

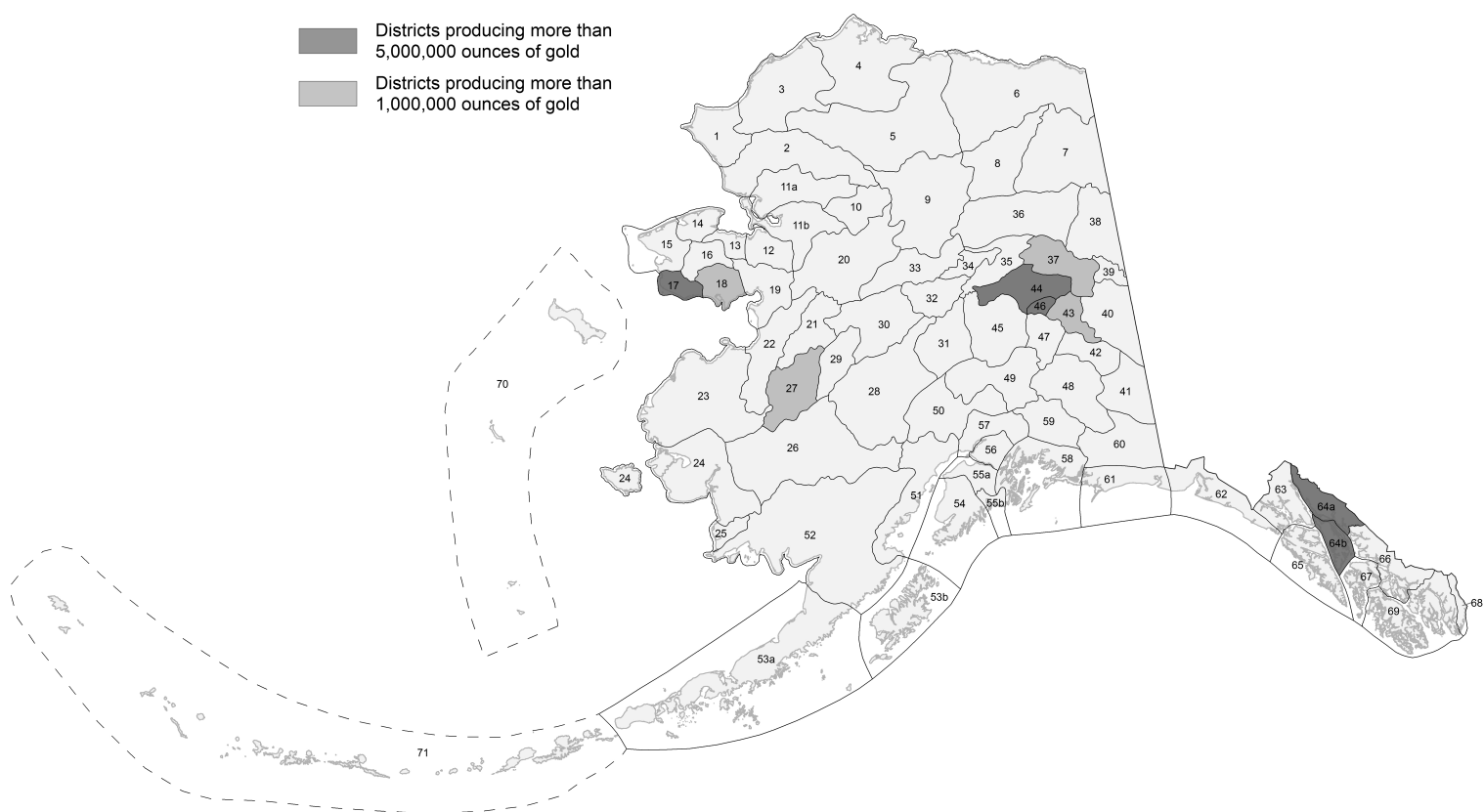
^bNot included in total for Fairbanks district.

^cMost placer gold production included in Willow Creek district.

^dIncludes lode production from Glacier Bay area and placer production from Lituya Bay area.

^eProduction 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.

- Districts producing more than 5,000,000 ounces of gold
- Districts producing more than 1,000,000 ounces of gold





Top. Ore processing facilities at the Pogo mine in interior Alaska, which changed ownership to Northern Star Resources Limited in mid-2018. Photo from: Northern Star Resources Limited, September 27, 2018, Pogo gold mine site visit (presentation); last accessed October 4, 2018; www.nsr ltd.com/wp-content/uploads/2018/09/Pogo-Site-Visit-Presentation-27-09-2018.pdf.

Below. Gold ore at the Pogo mine. Photo courtesy of William Groom, DMLW.



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

