

Special Report 77

# ALASKA'S MINERAL INDUSTRY 2021

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



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# Alaska's Mineral Industry 2021

David J. Szumigala<sup>1</sup>

**Cover.** Initial blast at the new Gil Mine during Kinross Fort Knox's official groundbreaking ceremony on September 23, 2021. Photo provided by Kinross Gold Corp.

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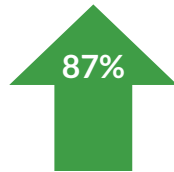
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# EXECUTIVE SUMMARY

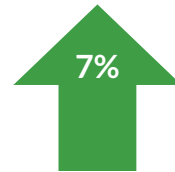
Exploration  
Expenditures



Development  
Expenditures



Estimated  
Revenue to Industry



This summary of the status of Alaska's mineral industry for 2021 is the 41st such annual report produced by the Department of Natural Resources, Division of Geological & Geophysical Surveys. Published for almost half of a century, the annual report endeavors to provide a consistent and factual snapshot of mineral industry activity in Alaska. It also serves as the authoritative historical record of mining in the state.

The reported value of Alaska's mineral industry in 2021 totaled \$3.4 billion, an increase of seven percent from 2020. The total value for 2021 is a composite of the year's expenditures on exploration and development, plus the revenue to the operators/owners from the produced mineral commodities.

Alaska's mining industry surged forward in 2021, after the COVID-19 pandemic sent shockwaves through the global economy and disrupted planned projects in 2020. COVID-19 management protocols and quarantine measures still impacted all projects, but adaptations made in 2020, the availability of vaccines and significantly lower COVID-19 rates in Alaska allowed projects to carry forward in 2021. Staffing challenges and supply chain limitations continued through 2021. The many exploration projects scaled back or delayed in 2020 were restarted in 2021. Improving metal prices due to supply curtailments, energy shortages, shipping bottlenecks, and strong demand improved cashflow for Alaska's precious metal mines.

The U.S. Geological Survey (USGS) estimated that the value of nonfuel mineral

production in Alaska for 2021 was \$3.89 billion, ranking sixth among the 50 states and accounting for 4.30 percent of total U.S. mineral production in 2021. The estimated revenue to Alaska's mineral industry for nonfuel mineral production for 2021 was \$2.77 billion. This estimated revenue value accounts for actual sale prices and includes smelting, refining, and transportation costs.

Zinc continued to be the top metal produced in 2021, accounting for 47 percent of Alaska's total metal production. Gold followed at 34 percent of total production, with total ounces produced up almost 4 percent. Estimated silver production dropped by almost 1.3 million ounces, while lead production dropped by approximately 1,700 tons.

Development expenditures in Alaska increased 27 percent to \$339.1 million in 2021. Projects and capital expenditures delayed in 2020 due to the pandemic were advanced with strong mitigation measures. Currently, only capital expenditures at Alaska's operating mines are contributing to this category, which is sensitive to the timing of high-cost individual projects.

Mineral exploration expenditures rose sharply to \$273.1 million, in line with global trends, and an 87 percent increase from 2020 spending levels. Alaska's remote, summer-season exploration projects posted a strong rebound from disruptions and uncertainty in 2020 associated with the emerging COVID-19 pandemic. Exploration spending on gold projects increased 66 percent to \$167 million dollars in 2021 and represented 61 percent of total mineral exploration expenditures.

Active mining claims and prospecting sites covered more than four million acres of Alaska in 2021, an increase of 6 percent from 2020. State mining claims, which account for 97 percent of the total claimed land, increased by 6 percent, while the total area of Federal mining claims increased by 8 percent in 2020.

Mineral industry employment increased modestly across most sectors in 2021, up fourteen percent to an estimated 3,690 full-time-equivalent jobs. The steepest increase in employment was tied to increased mineral exploration activity, and increased employment at Alaska's operating mines also increased significantly.

Estimated revenues to the State of Alaska and municipalities from mineral-industry-specific

fees, rents, sales, royalties, and taxes amounted to more than \$95.4 million in 2021, an almost \$25 million drop from 2020 revenues.

Twenty-four companies publicly reported drilling programs in Alaska in 2021. Total drilling, including both publicly reported and confidential drilling footages, increased to 2,252,629 feet. Thirty-three individual projects reported 884,241 feet of exploration drilling in 2021, an increase from twenty projects in 2020, as well a 32 percent increase in footage drilled. Reverse circulation (rotary) drilling totaled 94,655 feet in 2021. This is a 70 percent increase from the 2020 reported hardrock rotary footage total.



**Photo 1.** Midnight Sun RC rig at the SH-1 vein on the Unga project. Photo provided by HelioStar Metals Ltd.

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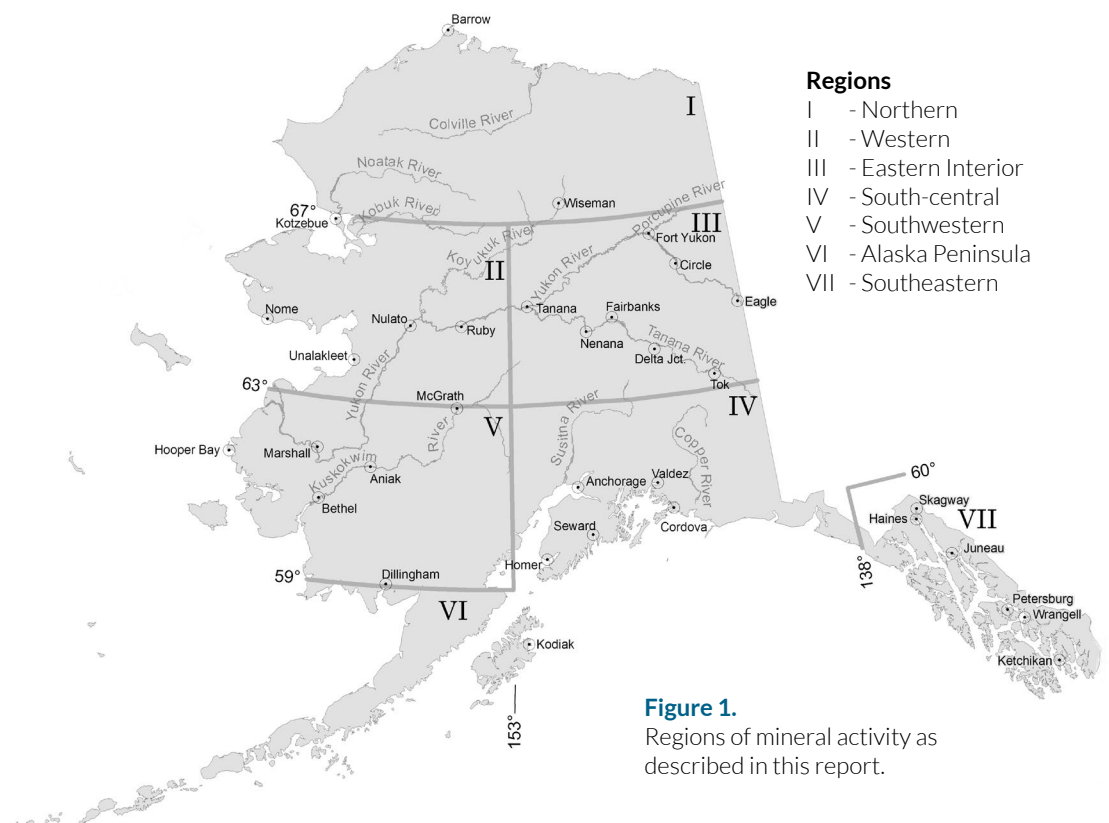
# INTRODUCTION

This summary of the status of Alaska's mineral industry for 2021 is the 41st such annual report produced by the Department of Natural Resources (DNR), Division of Geological & Geophysical Surveys (DGGS). The authors of this annual report endeavor to provide a consistent and factual snapshot of mineral industry activity in Alaska. This report serves as the authoritative historical record of mining in the state, which is vital for informed decision-making by state and local governments, the legislature, land managers, industry, Native corporations, and the public.

Alaska's mineral endowment 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 and Treadwell mines near Juneau, and placer platinum from the Goodnews Bay Mining District. Alaska's mineral wealth is shown by major deposits currently in production that include Red Dog, Greens Creek, Pogo,

Fort Knox, Kensington, and Usibelli Coal mines. The Dawson mine in Southeast Alaska is a small-volume gold producer. Alaska added the Gil Mine, a satellite deposit to the Fort Knox Mine, as an additional operating gold mine in 2021.

Future domestic sources of critical raw materials needed for twenty-first-century technologies are present throughout Alaska. Promising advanced-exploration and permitting-phase projects include Donlin Gold, Pebble, Livengood, Estelle, Niblack, Palmer, Arctic, Bornite, and Lik deposits. These projects and others, found throughout Alaska's seven geographic regions defined for this report (fig. 1), collectively represent a significant proportion of the U.S.'s domestic gold, silver, copper, and base-metal resources. These deposits demonstrate that there are still extremely large mineral deposits to be developed in Alaska. Significant resources of other commodities include the advanced exploration projects at Graphite Creek (graphite deposit) and Bokan Mountain (rare-earth element [REE] deposit).



Without a doubt, Alaska holds other world-class mineral deposits yet to be discovered. In 2021, the Fraser Institute annual survey of mining companies ranked Alaska fourth out of 84 worldwide jurisdictions for overall investment attractiveness by mining and exploration companies, which considers geologic potential as well as government policy factors that affect exploration investment. Alaska also ranked first in security and ninth for taxation regime.

Alaska ranked second on the best practices mineral potential index. This index highlights a region's geology and potential to host mineral deposits. Alaska was perceived to have mining-friendly regulatory and fiscal policies, as well as attractive geological databases. Seventy percent of survey respondents for Alaska indicated that timelines for permit-approval decisions were met between 80 and 100 percent of the time—the highest share of all surveyed jurisdictions.

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, security 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. The minerals industry has been, and continues to be, a driving force in the state's economy through significant local employment, infrastructure, and government revenue.

Alaska's mining industry continued to be impacted by the COVID-19 pandemic during 2021. The virus-associated mitigation measures and restrictions resulted in some delayed or scaled-back projects, and a few exploration projects were canceled entirely. Evolving quarantine policies and availability of a vaccine eased COVID-19 impacts throughout the year but



**Photo 2.** Truck passing through air wash system after unloading concentrate from the Red Dog Mine at the concentrate storage building at the Red Dog port site. Photo provide by Teck Alaska Inc.

continued to add significant expenses for companies. Scarcity of necessary parts and commodities, driven by supply chain issues and manpower shortages, led to increased costs and modified some projects' planned work.

All operations reported increased productivity, but whole-year production remained within normal ranges. The effects of the pandemic on the global economy lessened during 2021, and prices rose for base and precious metals. Alaska mine revenue increased slightly as well, by almost two percent, to \$2.84 billion (table 1). Mineral development expenditures in Alaska totaled \$339.1 million in 2021, up 27 percent from \$267.8 million in 2020. Exploration expenditures rose dramatically by 87 percent to \$273.1 million in 2021. Overall, the value of Alaska's mining industry rose eight percent to an estimated \$3.45 billion.

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 replies to questionnaires and news media articles. Government data on employment, government revenue, and mining claims are provided by the Alaska DNR Division of Mining, Land & Water (DMLW), the Alaska Department of Labor and Workforce Development (DLWD), the Alaska Department of Revenue (DOR), and the U.S. Mine Safety and Health Administration (MSHA). 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 Alaska energy sector prices and available coal heating values. Industrial materials prices are based on regional rates reported by operators and rates reported by the U.S. Geological Survey (USGS)

in their annual mineral commodity summaries. Many of the numbers contained in this report are estimates, with commodity values and company revenue estimated from theoretical first market values 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.

**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), 1981–2021. Average annual values are given for 1981–1985, 1986–1990, 1991–1995, and 1996–2000; individual year totals are provided for 2001–2021

Year	Exploration Expenditures (\$ millions)	Development Expenditures (\$ millions)	Theoretical First Market Value (\$ millions) <sup>a</sup>	Estimated Revenue to Industry (\$ millions) <sup>b</sup>
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 <sup>c</sup>	\$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 <sup>c</sup>	\$2,759.2	–
2016	\$58.9	\$217.4	–	\$2,536.6
2017	\$120.8	\$299.5	–	\$2,724.7
2018	\$140.1	\$334.1	–	\$2,428.1
2019	\$171.0	\$347.8	–	\$2,530.0
2020	\$145.9	\$267.8	–	\$2,790.9
2021	\$273.1	\$339.1	–	\$2,840.0

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

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

<sup>b</sup>Estimated revenue to industry is compiled from 1) revenue figures reported for the calendar year by major mine operators (accounting for actual sale

prices and including smelting and refining charges and transportation costs), except a theoretical first market value is substituted when actual mine revenue is unavailable; 2) calculated value of industrial materials (rock, sand, and gravel) produced from some State and Federal lands (table 10); and estimated gross operating income of placer mining operations from mining license tax forms as reported by the Department of Revenue (table 11).

<sup>c</sup>2011 and 2015 total missing significant expected data.

– = Not reported

## EMPLOYMENT

Total mineral industry employment in 2021 is estimated at 3,690 full-time-equivalent jobs, an overall increase of about 465 jobs, or 14 percent, from 2020 (table 2). This is the largest estimated total mineral industry employment since 2013. Employment related to gold production in 2021 was 1,425 full-time-equivalent jobs; more than 39 percent of mining production jobs in all sectors (table 2).

The Alaska mineral exploration sector gained an estimated 150 jobs, up 50 percent from 2020. The estimated employment increase in

exploration projects reflects the sharp rise in 2021 mineral exploration expenditures. Exploration employment was estimated for 22 of 86 lode exploration projects using their reported exploration expenditure in conjunction with cost-per-project ratios averaged from 64 projects with complete employment data.

Estimated employment in mine development activities dropped by 24 jobs in 2021, while mine production employment increased by 340 jobs, a combined increase of 315 positions (11 percent). Changes in the number of development

**Table 2.** Estimated Alaska mineral industry employment, 2009–2021<sup>a</sup>, as compiled from public documents, MSHA reporting<sup>b</sup>, 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.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<b>Gold/silver mining</b>													
Placer <sup>c</sup>	399	405	439	477	432	241	224	222	193	192	159	141	139
Lode	832	1,008	1,085	1,206	1,176	1,054	1,047	1,253	1,193	1,132	1,174	1,002	1,286
Polymetallic mining	321	350	364	386	390	287	303	306	324	316	342	326	381
Base metals mining	413	550	586	530	550	446	475	526	606	482	502	659	673
Recreational mining	36	35	41	52	55	7	-	-	-	-	-	-	-
<b>Industrial minerals</b>													
Sand and gravel	286	313	307	424	565	30	-	-	-	-	-	-	-
Rock	83	11	28	60	19	65	-	-	-	-	-	-	-
Coal <sup>d</sup>	117	140	140	144	120	115	112	100	89	99	96	102	100
Peat <sup>d,e</sup>	-	3	3	4	-	<1	-	-	-	-	-	-	-
Tin, jade, soapstone, ceramics, platinum	-	-	-	-	1	1	-	-	-	-	-	-	-
Production (total of above categories)	2,487	2,815	2,993	3,283	3,308	2,246	2,230	2,660	2,602	2,458	2,545	2,427	2,767
Mineral development	371	537	422	535	358	468	555	412	536	638	622	494	470
Mineral exploration	422	520	535 <sup>f</sup>	548	385	253	116	160	254	373	319	303	453
<b>Total</b>	<b>3,280</b>	<b>3,872</b>	<b>3,950</b>	<b>4,366</b>	<b>4,051</b>	<b>2,967</b>	<b>2,901</b>	<b>3,232</b>	<b>3,392</b>	<b>3,469</b>	<b>3,486</b>	<b>3,225</b>	<b>3,690</b>

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

<sup>b</sup>MSHA data: [arlweb.msha.gov/OpenGovernmentData/DataSets/MinesProdYearly.zip](http://arlweb.msha.gov/OpenGovernmentData/DataSets/MinesProdYearly.zip)

<sup>c</sup>See table 11 for updated information on placer employment calculations.

<sup>d</sup>Coal and peat employment numbers are combined in 2009.

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

<sup>f</sup>Average of 520–550 range reported for 2011.

- = Not reported

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

jobs may be tied to the cycle of specific large capital projects at Alaska's mines. However, 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, even though there are recognized limitations to this estimation method.

Placer employment continued a downward trend, and it is estimated that more than two-thirds of placer jobs (calculated as full-time equivalents) have been lost since the 2012 high. Estimated placer employment fell by two percent, or two jobs, from 2020 to 2021. Placer mining statistics are collected by the DOR and are 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 the DOR from operators. Placer mining employment in 2020 and 2021 was estimated from the number of placer mines that reported gross operating income on mining license tax returns. This methodology is fully explained in table 11. Placer mine employment is challenging to quantify due to the large number of small or seasonal operations, sole-proprietors, and family-based businesses.

MSHA data indicate that coal mining employment remained steady from 2020 to 2021. Metal mining employment increased by 140 jobs (six percent), placer mining employment increased by 13 jobs (seven percent), and industrial materials production (rock, sand, and gravel) full-time-equivalent employment fell by 71 jobs (12 percent). This trend contrasts slightly with a more negative trend from reported material-sale volumes on public land, which decreased by 20 percent in 2021 (table 12). While materials-sector employment (and production volumes and values) is underreported, the MSHA dataset captures 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 the DGGs. Many exploration companies and mine operators voluntarily responded to questionnaires with 2021 employment information. Affidavits of annual labor also provided 2021 employment data for hard-rock exploration projects. Additional employment information was obtained from the 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 on 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 a 10-hour workday unless actual average annual employment numbers are provided.

The DLWD provided 2021 mining employment and wage statistics based on 126 reporting units (companies) consisting of 50 metal ore, 34 coal and nonmetallic-mineral quarrying, and 42 mining-support-activity units. Mining and support activities provided 3,573 jobs, up ten percent from 3,249 jobs in 2020. Mining gained 208 full-time employees in 2021, an almost seven percent increase from 2020. The DLWD data show that nonmetallic-mineral-product manufacturing provided 232 jobs, which includes an average of 212 jobs in cement and concrete manufacturing, and metal and mineral merchant wholesalers provided an average of 112 jobs during 2021.

Sixteen boroughs or census areas reported mining (excluding oil and gas) employment in 2021, according to the DLWD data. The Juneau and Fairbanks areas (combined Fairbanks North Star Borough and Southeast Fairbanks Census Area) accounted for more than 67 percent of mining employment in the state. In 2021, the Fairbanks area gained four new mining-related businesses, employed 250 additional workers, an increase of slightly more than 16 percent, and had the highest number of mining jobs (1,577) among

Alaska boroughs or census areas. The City and Borough of Juneau came in second with 843 jobs, up almost five percent from 804 jobs in 2020.

Wages for mining-sector jobs, averaging \$115,321 in 2021, were some of the highest among major industries in Alaska, and almost double the 2021 average annual wage of \$62,123 for all industries in Alaska. The average mining-sector wage decreased slightly more than two percent from \$117,902 in 2020, while the average private-sector wage grew almost two percent, slightly narrowing the huge disparity between these wages. Total wages paid by non-oil-and-gas mining firms in 2021 were \$382,719,975, up more than four percent from 2020. All non-oil-and-gas mining firms showed growth in total annual wages in 2021 except for those of metal and mineral merchant wholesaler firms, which decreased slightly more than 14 percent from 2020.

The DLWD employment data are based on wage records and include part-time jobs, but do not include the self-employed and working family members not covered under unemployment insurance. Most 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 the dataset.

An in-depth report on the economic impact of the mining industry in Alaska, prepared by the Alaska Miners Association (AMA) in consultation with the McKinley Research Group, estimates that in 2021, Alaska's mining industry provided 5,400

direct mining jobs and an additional 5,400 indirect jobs. Direct and indirect wages totaled an estimated \$985 million. The AMA report uses surveys and other research and analysis methods to include mining industry employment not captured by the DLWD and the DGGs datasets. Based on data from the six large producing mines, 74 percent of employees at those mines are Alaska residents. Mining employees live in about 95 communities throughout Alaska.

The Alaska mineral industry is an important Alaska Native employer. According to the AMA McKinley Research Group report, 52 percent of the year-round jobs at the Red Dog Mine are filled by NANA Regional Corporation (NANA) shareholders. NANA shareholders also accounted for 47 percent of the employees and contractors working at the Upper Kobuk Minerals project in 2021. Alaska Natives accounted for 54 percent of the development jobs at the Donlin Gold project, while 66 percent of the workers at the Pebble project were Alaska Native shareholders or their descendants.



**Photo 3.** Preparing sonic drill core for logging at the Graphite One project. Photo: Graphite One Inc.



## GOVERNMENT REVENUES FROM ALASKA'S MINERAL INDUSTRY

In 2021, government revenue from Alaska's mineral industry totaled \$95.4 million, compared to \$119.1 million in 2020 (table 3). Significant increases in state claim rentals, production royalties, Alaska Industrial Development and Export Authority (AIDEA) facility user fees, and corporate income tax balanced significant decreases in state material sales, mining license tax, and payments to municipalities. 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. Receipts from the Alaska Railroad Corporation are for shipping commodities related to mineral industry activities. Additionally, the DNR reported that \$146,547 in bond pool payments were received in 2020.

State corporate income tax collections in fiscal year (FY) 2021 increased steeply, with payments exceeding \$1.88 million. Extreme variability continues in this state revenue stream.

Operators and royalty payees reported total gross income of \$2.47 billion for mineral commodities that sold in tax year (TY) 2020 (December 1, 2019–November 30, 2020; table 4). This income is compiled from the mining license tax returns filed in TY 2021 and is the most recent figure available at the time of this report. Total gross income from mining activity that occurred in TY 2021 will be reported in a future edition of this report. Total gross income

from TY 2021 differs from the 2021 estimated revenue to industry of \$2.8 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 includes royalty-only taxpayers. Royalty-only taxpayers are typically landowners who receive revenue solely from a royalty share with no gross income from mining operations. All major mines in Alaska earn gross income from mining operations, and their income is included in the table's values. Income from Alaska's new Dawson Mine is included in the table for the 2019 and 2020 tax years.

Mining license tax collections fell significantly in 2021, declining 74 percent to \$9.0 million (table 3). The mining license tax is one percent of all tax collections collected by the DOR. The mining license tax, unlike the corporate income tax, does not have loss carryforward or carryback provisions, and therefore follows metal prices more closely. The DOR reported that 346 taxpayers submitted 429 mining license tax returns in TY 2021 for production in the 2020 tax year, of which 39 (10 percent) were liable for taxes on net taxable income from mining in the amount of \$295.6 million, a 23 percent decrease from TY 2019 net taxable income (table 4). Negative net taxable incomes from mining, at an average loss of \$125,926 per taxpayer, were reported by 117 taxpayers.

Revenue to municipalities declined in 2021 to \$43.6 million, a 14 percent drop from 2020 values. In Juneau, Fairbanks, and the Northwest Arctic Borough, revenue from mining-related activity was among the largest contributors to



**Photo 4.** Governor Mike Dunleavy presses the blast button at the opening of Gil Mine. Photo: Brenna Schaake, Kinross Gold Corp.

**Table 3.** Reported and estimated revenues paid to the State of Alaska and municipalities by Alaska's mineral industry, 2015–2021. The figures in this table will change as data are reviewed and updated; the table has been significantly updated to reflect Department of Natural Resources and Department of Revenue reporting for previous years. See footnotes for reporting sources and dates.

	2016	2017	2018	2019	2020	2021
<b>State mineral rents and royalties<sup>a,b</sup></b>						
State claim rentals	7,327,630	7,658,003	7,192,888	9,104,615	9,253,677	11,107,426
Production royalties <sup>c</sup>	2,816,884	3,125,925	2,472,558	797,152	169,482	1,631,483
Annual labor	331,986	374,244	392,085	438,098	331,210	376,412
<b>Subtotal</b>	<b>\$ 10,476,500</b>	<b>11,158,173</b>	<b>10,057,531</b>	<b>10,339,865</b>	<b>9,754,369</b>	<b>13,115,321</b>
<b>State coal rents and royalties<sup>b</sup></b>						
Rents	347,324	268,866	231,159	223,799	415,454	205,276
Royalties <sup>c</sup>	2,237,777	2,232,394	1,971,999	2,519,086	2,375,927	2,649,306
Bonus	-	-	100	-100	-	-
<b>Subtotal</b>	<b>\$ 2,585,101</b>	<b>2,501,260</b>	<b>2,203,258</b>	<b>2,742,785</b>	<b>2,791,381</b>	<b>2,854,582</b>
<b>State material sales<sup>b</sup></b>						
Mental Health	25,130	24,366	50,558	15,144	2,700	406,192
Division of Land	6,412,271	4,637,844	4,540,134	6,734,784	2,831,123	1,741,602
State Pipeline Coordinator's Office	121,994	288,511	93,359	47,327	916,856	294,673
<b>Subtotal</b>	<b>\$ 6,559,395</b>	<b>4,950,720</b>	<b>4,684,051</b>	<b>6,797,255</b>	<b>3,750,679</b>	<b>2,442,467</b>
<b>State mining miscellaneous fees<sup>b</sup></b>						
Filing fees	9,650	4,825	5,150	4,200	105,960	124,198
Bid bonus	193,963	-	-	-	205,506	-
Penalty fees	95,677	220,770	91,920	135,611	40,089	33,365
Exploration incentive app filing fee	-	-	-	-	-	-
Surface mine investment interest	19,690	-	-	-	193,448	-
Surface coal mining app fee	7,218	8,000	7,342	-653	-	-
APMA mining fees	21,627	21,302	29,024	66,171	-	-
<b>Subtotal</b>	<b>\$ 347,826</b>	<b>254,897</b>	<b>133,436</b>	<b>205,329</b>	<b>545,002</b>	<b>157,563</b>
<b>Other Fees</b>						
AIDEA - Facilities use fees <sup>d</sup>	10,709,000	10,014,951	9,081,619	8,129,483	6,975,615	28,000,000
State fuel taxes <sup>e</sup>	2,066,313	1,338,843	1,411,896	1,015,005	1,005,467	1,367,505
State corporate income tax <sup>f</sup>	1,636,850	-734,744	34,594,928	6,859,747	-7,733,308	1,880,036
Mining license tax <sup>g</sup>	11,131,203	41,525,192	47,297,409	47,777,544	35,043,196	9,001,811
Large mine permit coordination program receipts <sup>h</sup>	1,364,952	968,827	928,035	991,271	1,193,278	1,125,259
Alaska Railroad receipts <sup>i</sup>	17,500,000	21,200,000	15,900,000	17,400,000	15,200,000	15,500,000
<b>State Total</b>	<b>\$ 64,377,140</b>	<b>93,178,119</b>	<b>126,292,163</b>	<b>102,258,284</b>	<b>68,525,679</b>	<b>75,444,544</b>
Payments to municipalities <sup>j</sup>	22,656,383	48,628,626	34,282,140	41,481,284	50,555,237	43,583,242
<b>Total</b>	<b>\$ 87,033,523</b>	<b>141,806,745</b>	<b>160,574,303</b>	<b>143,739,568</b>	<b>119,080,916</b>	<b>119,027,786</b>

<sup>a</sup>Includes upland lease and offshore lease rentals. Figures are reported by calendar year by the Alaska Department of Natural Resources.

<sup>b</sup>Figures are reported by calendar year by the Alaska Department of Natural Resources.

<sup>c</sup>Reported on a cash basis; payments actually received during the given year.

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

<sup>e</sup>Values from 2016–2021 were reported by the major operating mines, less their fuel tax refund.

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

primarily to timing differences.

<sup>g</sup>In 2012 and later, mining license tax was not collected on materials. Figures are reported by fiscal year. <http://tax.alaska.gov/programs/programs/reports/AnnualData.aspx?60610>

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

<sup>i</sup>Alaska Railroad revenue for transportation of coal, sand, and gravel. From *The Economic Benefits of Alaska's Mining Industry* published by the Alaska Miners Association, February 2021, and *The Economic Benefits of Alaska's Mining Industry* published by the Alaska Miners Association, May 2022. <https://www.alaskaminers.org/economic-benefits>.

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

**Table 4.** Mining tax analysis by tax bracket for the 2018–2020 tax years, based on mining license tax returns. Analysis includes income from operations plus royalty income, including both royalty-only tax payers and those with both income from operations and royalty income. Information provided by the Alaska Department of Revenue. The figures in this table will change as data are reviewed and updated. Note yearly values reported by the Department of Revenue are adjusted to align with the production year.

Bracket	Marginal tax rate	No. of taxpayers	Total gross income	Net taxable income*	Net income as percentage of gross	Total tax liability	Average gross income	Average taxable income	Average tax liability
<b>Tax Year 2018</b>									
Under \$0	0%	135	\$678,343,577	\$ -68,594,263	-10%	\$0	\$5,024,767	-\$508,106	\$0
\$0 to \$40,000	0%	228	\$7,369,147	\$1,090,636	15%	\$0	\$32,321	\$4,783	\$0
\$40,001 to \$50,000	3%	10	\$494,845	\$414,741	84%	\$12,442	\$49,484	\$41,474	\$1,244
\$50,001 to \$100,000	5%	14	\$3,771,833	\$991,149	26%	\$35,557	\$269,417	\$70,796	\$2,540
Over \$100,000	7%	18	\$1,677,817,899	\$514,427,874	31%	\$35,627,720	\$93,212,105	\$28,579,326	\$1,979,318
<b>Total</b>		<b>405</b>	<b>\$2,367,797,301</b>	<b>\$448,330,137</b>		<b>\$35,675,719</b>			
<b>Tax Year 2019</b>									
Under \$0	0%	121	\$748,519,050	\$ -120,400,547	-16%	\$0	\$6,186,108	-\$995,046	\$0
\$0 to \$40,000	0%	199	\$7,663,240	\$1,184,776	15%	\$0	\$38,509	\$5,954	\$0
\$40,001 to \$50,000	3%	16	\$1,684,884	\$694,158	41%	\$20,825	\$105,305	\$43,385	\$1,302
\$50,001 to \$100,000	5%	8	\$2,368,385	\$568,008	24%	\$20,400	\$296,048	\$71,001	\$2,550
Over \$100,000	7%	18	\$1,624,717,744	\$384,601,594	24%	\$26,611,268	\$90,262,097	\$21,366,755	\$1,478,404
<b>Total</b>		<b>362</b>	<b>\$2,384,953,303</b>	<b>\$266,647,989</b>		<b>\$26,652,493</b>			
<b>Tax Year 2020</b>									
Under \$0	0%	117	\$24,673,748	\$ -14,733,373	-60%	\$0	\$210,887	-\$125,926	\$0
\$0 to \$40,000	0%	222	\$9,987,015	\$1,165,992	12%	\$24,086	\$44,987	\$5,252	\$108
\$40,001 to \$50,000	3%	6	\$284,431	\$244,593	86%	\$7,338	\$47,405	\$40,766	\$1,223
\$50,001 to \$100,000	5%	11	\$3,469,689	\$819,235	24%	\$29,962	\$315,426	\$74,476	\$2,724
Over \$100,000	7%	22	\$2,429,283,535	\$294,522,491	12%	\$20,072,579	\$110,421,979	\$13,387,386	\$912,390
<b>Total</b>		<b>378</b>	<b>\$2,467,698,418</b>	<b>\$282,018,938</b>		<b>\$20,133,965</b>			

\*Net income taxable under the mining license tax

Note: Taxpayers with negative income (under \$0) are not a separate bracket, but are reported separately to distinguish between large money-losing operations and small operations with zero or positive income. See page 7 for the differences between Total Gross Income (table 4) and the Estimated Revenue to Industry (table 1).

municipal and borough budgets. In addition, the mining industry paid about \$3 million to Native corporations, and Alaska communities received more than \$3.3 million in charitable donations from the mining industry. The Alaska mining industry paid \$98 million in 7(i) payments to Alaska Native Claims Settlement Act (ANCSA) Regional Corporations in 2021.

Mining companies paid the largest share of local taxes in the Northwest Arctic Borough, Fairbanks North Star Borough, Denali Borough, and City and Borough of Juneau. Tax payments to local governments totaled an estimated \$44 million annually. Kinross Fort Knox paid \$13 million in property taxes to the Fairbanks North Star Borough, making the mine the largest “single property” taxpayer in the Borough. Usibelli Coal Mine paid taxes to the Fairbanks North Star Borough, Matanuska-Susitna Borough, and Denali Borough. Greens Creek Mine and Kensington Mine paid \$2.6 million and \$1.4 million, respectively, in property taxes to the City and Borough of Juneau. These two mines are the largest taxpayers in the City and Borough of Juneau.

Red Dog Mine paid \$25 million in payment in lieu of taxes (PILT) to the Northwest Arctic Borough, plus \$6 million in payments to the new Village Improvement Fund. Red Dog Mine is the Borough’s single largest source of revenue. The Borough has no sales tax or property tax revenues.

In certain jurisdictions, mining companies pay sales tax on their local purchases of goods and services. For example, in Juneau, Greens Creek Mine paid an estimated \$727,230 in sales taxes.

The AMA’s report on mining also lists other benefits to the state. In 2021, the Alaska Railroad Corporation received approximately \$15.5 million from transportation of coal, rock, sand, and gravel. The AMA estimates that Alaska’s mines, mine development projects, and advanced exploration projects spent an estimated \$1.1 billion on a wide variety of goods and services in support of their operations, while purchasing about \$640 million in goods and services in 2021 from about 400 Alaska vendors to support operations.



**Photo 5.** Exploration at the Eagle Prospect.  
Photo: Kirsten Kremer,  
Contango ORE Inc..

# MINERALS-RELATED GOVERNMENT ACTIVITIES

## U.S. Geological Survey

The USGS Mineral Resources Program had multiple projects focused on the geologic framework and mineral resources of Alaska in 2021. Alaska Science Center research staff in Anchorage conducted field-based studies of the tectonic and metallogenic evolution of the Yukon–Tanana uplands, eastern Alaska, and on the geology and mineral resource potential of mafic and ultramafic rocks in Interior Alaska.

Research staff at the Geology, Geophysics, and Geochemistry Science Center in Denver, Colorado, published the results of an exploration geochemistry study near the Taurus porphyry copper deposit in eastern Interior Alaska that identified potential indicator minerals in stream sediments and assessed the utility of indicator minerals and hydrogeochemistry (Kelley and Graham, 2021, [doi.org/10.1016/j.apgeochem.2020.104821](https://doi.org/10.1016/j.apgeochem.2020.104821)). Ongoing work extends these exploration methods in the area containing the Pogo deposit in the Goodpaster Mining District. Research staff from Denver also continued to conduct studies on gold vein samples from Pogo and the Black Mountain district placer, together with gold provenance studies in the Fortymile and Fairbanks mining districts involving characterization of populations of gold particles according to both alloy compositions and suites of mineral inclusions (microchemical characterization).

Research staff in Anchorage and Denver conducted a GIS-based evaluation of the potential for lode gold associated with porphyry, reduced intrusion-related, epithermal, and orogenic deposits (Karl and others, 2021, [doi.org/10.3133/ofr20211041](https://doi.org/10.3133/ofr20211041)). Another similar report was completed for sediment-hosted lead-zinc deposits in Alaska (Kelley and others, 2021, [doi.org/10.3133/ofr20201147](https://doi.org/10.3133/ofr20201147)). Additional geochemical and geophysical datasets were

added to the analysis to help reduce uncertainty in the evaluation rankings. Work continued on improving and adapting the evaluation method for sediment-hosted copper, volcanogenic massive sulfide (VMS), and porphyry copper deposits. A topical study of the Graphite Creek deposit, Seward Peninsula, was commenced to develop a geological model and salient criteria to be used for GIS analysis of regional flake graphite potential. Also, a USGS three-part mineral resource assessment was completed for tungsten skarn deposits in the Yukon–Tanana uplands. A quantitative assessment was conducted in the vicinity of Fairbanks, and a qualitative assessment was done for the rest of the uplands.

Research staff from Anchorage and Denver also participated in national science planning for the USGS Earth Mapping Resource Initiative (Earth MRI) and developed multiple Alaska focus areas that have critical mineral potential and require new geological mapping and geophysical data acquisition. A USGS Open File Report presenting Alaska focus areas that have potential for antimony, barite, beryllium, chromium, fluor-spar, hafnium, magnesium, manganese, uranium, vanadium, and zirconium is scheduled to be published in 2022.

More than 1,500 archived stream-sediment samples and accompanying quality control samples were reanalyzed to improve the stream geochemical dataset for Alaska and to support ongoing USGS studies. Sediment samples were primarily from the USGS Mineral Resources Program's sample archive in Denver, Colorado, but a few were from the DGGs Geologic Materials Center (GMC) in Anchorage, Alaska. The new chemical analyses were released as an Open-File Report (Wang and others, 2021, [doi.org/10.3133/ofr20211058](https://doi.org/10.3133/ofr20211058)).

Research staff authored a book chapter, *Tectonic and magmatic controls on the metallogenesis of porphyry deposits in Alaska*, in the Canadian Institute of Mining, Metallurgy and Petroleum's book *Porphyry deposits of the northwestern Cordillera of North America: A 25-year update* (Sharman, Lang, and Chapman, eds., 2021, [pubs.er.usgs.gov/publication/70217720](https://pubs.er.usgs.gov/publication/70217720)).

The Alaska Mapping Executive Committee (AMEC) celebrated the completed collection of elevation data covering the entire state as a priority focus of the nation's 3D Elevation Program. Multiple federal agencies and the State of Alaska have contributed over \$68 million since 2010 to complete the project. All the data are now fully processed and can be accessed through USGS and State of Alaska public websites (<https://doi.org/10.3133/fs20133083>). The new elevation data have been used to create a new statewide series of accurate digital topographic maps for Alaska. AMEC established a coastal mapping subcommittee to prioritize and advance a statewide coastal-topography and nearshore bathymetric mapping program. This program will be critical as new shipping lanes open and ocean transfer of people and goods expands commerce in regional, state, and federal waters. The program may also be beneficial to develop and process offshore placer materials.

Alaska Science Center hydrologist Jenn Hamblen hosted the quarterly meeting on the USGS Alaska Transboundary Rivers Project with stakeholders in Alaska and Canada on September 24, 2021. The USGS project collects discrete and continuous water quality and solids data for five transboundary watersheds: the Alsek, Taku, Stikine, Unuk, and Salmon rivers. There is active mining on the Canadian side of the border in all but one of these watersheds. Participants included other researchers and stakeholders from Tribes, agencies, and nonprofit organizations. Goals included collaborating with researchers to help ensure data is comparable, working with partners to fill in gaps in data collection on the watershed scale, and seeking feedback to help ensure that data collected from the USGS project meets stakeholder needs. For more information about

USGS transboundary rivers monitoring visit [www.usgs.gov/centers/asc/science/usgs-transboundary-river-monitoring-southeast-alaska](http://www.usgs.gov/centers/asc/science/usgs-transboundary-river-monitoring-southeast-alaska).

Alaska Science Center-led collaborative research on the geologic and metallogenic framework of Alaska's eastern Interior produced numerous USGS data releases presenting U-Pb geochronology, Re-Os geochronology, zircon trace element geochemistry, and whole rock data. The data are available through USGS Science Base ([www.sciencebase.gov](http://www.sciencebase.gov)) and the Alaska Science Center Data Repository ([usgs.gov/centers/alaska-science-center/data](https://usgs.gov/centers/alaska-science-center/data)). These data releases accompany a forthcoming paper detailing the geochronology and time-space evolution of the Taurus district in eastern Interior Alaska (Kreiner and others, in press). Research staff in Anchorage and Denver also continued to collaborate and work on mapping and geochronology of gold veins in the Goodpaster Mining District in collaboration with industry partners.

## U.S. Bureau of Land Management

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

Related to land management, BLM continued research, identification, inventory, and inspection of closed Federal mining claims in anticipation of conveying those lands to the State of Alaska as the subject lands become available for selection and conveyance.

To improve resource management plans (RMP) and other future land use planning efforts, a cooperative agreement between the BLM Alaska and DGGG was amended to expand geophysical surveys between the Fortymile River and Eagle, Alaska. Results were published in 2021 ([doi.org/10.14509/30755](https://doi.org/10.14509/30755)).

On January 19, 2021, the BLM released the record of decision (ROD) and approved RMP for the Bering Sea–Western Interior planning area. The approved RMP will guide future land management actions on 13.5 million acres of BLM-managed public lands south of the Central Yukon watershed to the southern boundary of the Kuskokwim River watershed and all lands west of Denali National Park and Preserve to the Bering Sea. It replaces the 1981 Southwest Management Framework Plan and a small portion of the 1986 Central Yukon RMP.

The Department of the Interior (DOI) issued Public Land Order (PLO) 7899 on January 19, 2021, revoking the withdrawal of approximately 9.7 million acres of BLM-managed public lands in northwest Alaska between the National Petroleum Reserve-Alaska and the Chukchi and Bering seas. This PLO revokes, in part, 11 PLOs issued in 1972 and 1973 in accordance with Sec. 17(d)(1) of ANCSA and Executive Order 10355. The revocation of these withdrawals would open unencumbered lands for mineral leasing or mineral entry. Subsequently, the DOI identified certain procedural and legal defects in the decision-making process, including insufficient analysis under the National Environmental Policy Act (NEPA). The DOI paused this PLO for two years to allow for further analysis.

## U.S. Forest Service

Alaska contains 17 percent of all U.S. Forest Service lands and contains two of the largest national forests in the nation. U.S. Forest Service lands in Alaska cover 21,956,250 total acres and contain 1,170 miles of trails, 3,644 miles of road, and 63 mines with operating plans.

In April 2021, Kinross Alaska announced a partnership with Trout Unlimited, a conservation organization, to support the Alaska Abandoned Mine Restoration Initiative, which is the first partnership of its kind in Alaska. Kinross, a major mining company, and Trout Unlimited are working alongside federal and state land-management agencies to restore the environment and mitigate the impact of historical mining operations.

The first project will help to restore a 2.2-mile segment of Resurrection Creek, which is located on the northern end of the Kenai Peninsula near Hope, Alaska. It is the site of one of Alaska's first gold rushes. Kinross made a \$540,000 donation to the project, and the partnership commemorated the occasion on August 13, 2021.

Public and private entities involved in the Resurrection Creek Phase II Restoration project include Trout Unlimited, Kinross Alaska, Hope Mining Company, the National Forest Foundation, and the Forest Service. The project is also sponsored by the U.S. Department of Commerce and the Alaska Department of Fish and Game.

## Alaska Department of Natural Resources Division of Mining, Land and Water

The DMLW manages mineral exploration and development on more than 96 million acres of State of Alaska land. In addition, the division reviews and approves the operation and reclamation plans for mining projects, including coal, on all state, federal, and private lands in Alaska. In 2021, the division's Large Mine Permitting Team coordinated hard rock mine permitting activities at Red Dog, Fort Knox, Pogo, Kensington, Greens Creek, Nixon Fork, and Manh Choh (Tetlin) mines.

The DMLW manages mineral exploration and placer mining through the Application for Permits to Mine in Alaska (APMA). In 2021, there were 579 operations with active APMAs, compared to 552 operations with active APMAs in 2020. Of these operations, 409 were for placer mining and exploration, 77 were for hard rock exploration, and 93 were for suction dredging activities.

The state regulates coal mining through the Coal Regulatory program. The DMLW inspected and permitted ongoing mining and reclamation at the Usibelli Coal Mine operations in Healy and inspection of inactive operations in the Wishbone Hill area. Flatlands Energy Corporation continued pursuing exploration

permits for coal exploration in the Canyon Creek area south of Skwentna, where seven exploration holes had been drilled in 2018.

The Abandoned Mine Lands (AML) program has been actively reclaiming legacy coal mines that were left abandoned in the Healy valley for the past seven years. The AML program is now focused on reclaiming the Cripple Creek pit, which will be accomplished in two separate phases. Phase I began in August of 2020 and is slated to be completed in the early summer of 2022. Phase II will begin as early as 2022. The AML program will remain active in the Healy valley for at least the next ten years, with the Apex pit projected for reclamation after the reclamation efforts are completed at the Cripple Creek pit.

A federal appeals board decision in September 2021 upheld the State of Alaska's ownership of 7,552 acres of submerged lands beneath the Kuskokwim River near McGrath. The Interior Board of Land Appeals' decision requires the BLM issue a recordable disclaimer of interest, confirming that the federal government had no ownership interest in the land. In other statehood defense actions, the State of Alaska sued in federal district court to force the DOI to terminate decades-long "temporary" public land orders withdrawing nearly 28 million acres of federal land from consideration for statehood land selections, Alaska Native allotments, or other beneficial uses.

The AIDEA proposed to construct a 211-mile private industrial access road from mile post 161 on the Dalton Highway to the Ambler Mining District. The road is intended to facilitate mine development and transportation of ore as part of the Ambler Access Project. The road would be controlled for approved commercial use only; no public access would be allowed. A 50-year Right-of-Way (ROW) permit for the full length of the Ambler Road was signed by the National Park Service (NPS), the BLM, and AIDEA on January 6, 2021. On October 20, 2021, the DMLW

received an application for a private, exclusive easement from the AIDEA for those portions of the road on state-owned, DMLW-managed lands. The application requests a 450-foot-wide easement over approximately 125 miles of the road alignment. The DNR plans to hold public meetings and classify the lands in 2022.

## **Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Mineral Resources Section**

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. 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.

The DGGS produced 24 publications related to mineral resources in 2021 (table 5). Since 1993, the data products of the Airborne Geophysical/ Geological Mineral Inventory (AGGMI) program have been an important component of successful resource-exploration programs; products have contributed to the private-sector discovery of more than 22 million ounces of gold resources in the Salcha River–Pogo and Livengood areas (fig. 2). State budget cuts impacted the AGGMI program and decreased its annual funding for data collection and publication. New geophysical surveys now rely on funding from external sources or the State of Alaska capital budget.



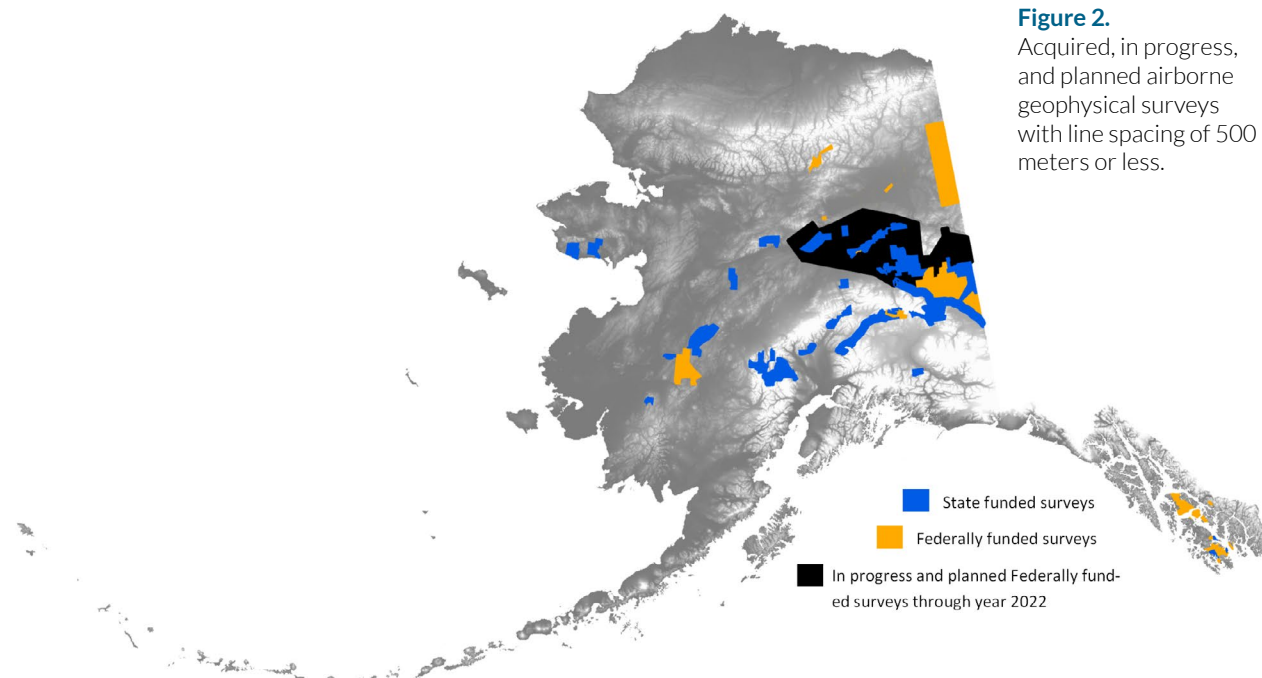
## Geologic Mapping and Geochemical Sampling

The DGGs Mineral Resources Section performs geological mapping and geochemical sampling across Alaska to decipher the complex geology of Alaska and aid in the evaluation of perceived mineral-rich lands. This effort has been aided in recent years with funding through the USGS's newly created Earth MRI program, which funds new geologic mapping and geophysical surveys of areas that are prospective for discovery of strategic and critical minerals. This

primarily federally funded project, supplemented with state-matching funds, allows the DGGs geologists to create and disseminate geophysical and geological map products. These types of products have historically been shown to stimulate mineral industry interest, staking, and exploration activity in Alaska, as well as increase revenue to the state. The Earth MRI project is being implemented in cooperation with the USGS and is expected to be a 10-year-long

**Table 5.** New mineral resource-related DGGs publications in 2021.

Geologic maps, reports, and geochemical data
Alaska's mineral industry 2019 – <a href="https://doi.org/10.14509/30658">doi.org/10.14509/30658</a>
Northeast Tanacross geologic mapping project, Alaska – <a href="https://doi.org/10.14509/30537">doi.org/10.14509/30537</a>
Introduction to the northeast Tanacross geologic mapping project – <a href="https://doi.org/10.14509/30538">doi.org/10.14509/30538</a>
Northeast Tanacross geologic map and map units and descriptions – <a href="https://doi.org/10.14509/30539">doi.org/10.14509/30539</a>
Metamorphic cooling history of the Fortymile River and Lake George assemblages from 40Ar/39Ar geochronology from the northeast Tanacross and southeast Eagle quadrangles, Alaska – <a href="https://doi.org/10.14509/30540">doi.org/10.14509/30540</a>
Structural geology observations in the northeast Tanacross map area – <a href="https://doi.org/10.14509/30541">doi.org/10.14509/30541</a>
Geochemical interpretation of samples of igneous rocks from northeast Tanacross – <a href="https://doi.org/10.14509/30542">doi.org/10.14509/30542</a>
Observations on the economic geology of the northeast Tanacross map area – <a href="https://doi.org/10.14509/30557">doi.org/10.14509/30557</a>
Magnetic modeling of the northeast Tanacross map area – <a href="https://doi.org/10.14509/30558">doi.org/10.14509/30558</a>
U-Pb zircon ages from bedrock samples collected in the Tanacross and Nabesna quadrangles, eastern Alaska – <a href="https://doi.org/10.14509/30732">doi.org/10.14509/30732</a>
Geologic investigation of the Ladue River-Mount Fairplay area, eastern Alaska – <a href="https://doi.org/10.14509/30734">doi.org/10.14509/30734</a>
Bedrock geologic map of the Ladue River-Mount Fairplay area, Tanacross and Nabesna quadrangles – <a href="https://doi.org/10.14509/30735">doi.org/10.14509/30735</a>
Metamorphism of the Ladue River-Mount Fairplay area – <a href="https://doi.org/10.14509/30736">doi.org/10.14509/30736</a>
Regional correlation of metamorphic rocks in the Ladue River-Mount Fairplay map area using trace-element geochemistry – <a href="https://doi.org/10.14509/30737">doi.org/10.14509/30737</a>
Structural geology of the Mount Fairplay-Ladue River area – <a href="https://doi.org/10.14509/30738">doi.org/10.14509/30738</a>
Geochemistry of the igneous rocks in the Ladue River-Mount Fairplay area – <a href="https://doi.org/10.14509/30739">doi.org/10.14509/30739</a>
Economic geology of the Ladue River-Mount Fairplay area – <a href="https://doi.org/10.14509/30740">doi.org/10.14509/30740</a>
U-Pb detrital zircon geochronology of Cretaceous-Cenozoic sedimentary rocks in the Ladue River-Mount Fairplay area, Alaska – <a href="https://doi.org/10.14509/30683">doi.org/10.14509/30683</a>
Preliminary bedrock geologic map database, northeastern Richardson mining district, Alaska – <a href="https://doi.org/10.14509/30676">doi.org/10.14509/30676</a>
U-Pb zircon data and ages for bedrock samples from the Richardson mining district, Big Delta Quadrangle, Alaska – <a href="https://doi.org/10.14509/30676">doi.org/10.14509/30676</a>
2020 Alaska mining industry update (presentation) – <a href="https://doi.org/10.14509/30592">doi.org/10.14509/30592</a>
Geophysical surveys
Eagle airborne magnetic and radiometric geophysical survey – <a href="https://doi.org/10.14509/30755">doi.org/10.14509/30755</a>
White Mountains airborne magnetic and radiometric geophysical survey – <a href="https://doi.org/10.14509/30756">doi.org/10.14509/30756</a>
Icy Cape airborne magnetic geophysical survey, Southeast Alaska – <a href="https://doi.org/10.14509/29742">doi.org/10.14509/29742</a>



**Figure 2.** Acquired, in progress, and planned airborne geophysical surveys with line spacing of 500 meters or less.

national program (beginning in 2019) funded at greater than \$10 million per year. In FY 2021, Alaska received \$1.1 million in federal funds under this program.

In June 2019, DGGs Mineral Resources Section geologists began their first Earth MRI field project by conducting 1,900 square miles of geologic mapping in the eastern Tanacross region. In 2021, the DGGs published a report on Mount Fairplay's REE potential ([dggs.alaska.gov/pubs/id/30736](https://dggs.alaska.gov/pubs/id/30736)), a geologic map and report for the eastern Tanacross area ([dggs.alaska.gov/pubs/id/30734](https://dggs.alaska.gov/pubs/id/30734)), and multiple reports on the geochronology of the eastern Tanacross region ([doi.org/10.14509/30732](https://doi.org/10.14509/30732)) and ([doi.org/10.14509/30683](https://doi.org/10.14509/30683)).

Due to COVID-19, fieldwork planned for summer 2020 was delayed until summer 2021. During June and early July, Mineral Resources Section geologists conducted field mapping in the western Tanacross region, an area of 1,730 square miles. The project targets a region of the state that has reconnaissance geologic mapping with the potential to host deposits of REEs and other critical minerals. The area is also prospective for copper, gold, and molybdenum. DGGs

Mineral Resources Section geologists spent 217 person days of helicopter-supported field work in the western Tanacross map area. A geologic map for the area is scheduled to be published by December 2022.

In mid-July 2021, fieldwork shifted to the Taylor Mountain region near Chicken, Alaska, an area of 900 square miles. This area includes the remainder of the Tanacross Quadrangle that was not previously mapped by DGGs geologists, as well as part of the Eagle Quadrangle. Known mineral systems within the Taylor Mountain map area include quartz veins with gold mineralization, intrusion related copper–gold deposits, and multiple placer gold deposits in the Fortymile Mining District. The area has the potential to host deposits of copper and gold, REEs, and other critical minerals. Mineral Resources Section geologists spent 103 person days of helicopter-supported field work in the Taylor Mountain map area. A geologic map for the area is scheduled to be published by May 2023.

As part of the Earth MRI program, the DGGs selected 3,311 historical USGS stream-sediment pulps for re-analysis with modern techniques, including a full suite

of elements, from across the Yukon-Tanana uplands. This data has been published and is available through the USGS ([doi.org/10.5066/P9WHRLXH](https://doi.org/10.5066/P9WHRLXH)), the DGGs ([maps.dggs.alaska.gov/geochem](https://maps.dggs.alaska.gov/geochem)), and for viewing through the DGGs Exploration Geochemistry Web App ([dggs.alaska.gov/maps-data/interactive-maps.html](https://dggs.alaska.gov/maps-data/interactive-maps.html)). This data is combined with 4,558 samples reanalyzed as a part of the State of Alaska's Strategic and Critical Minerals Project. This exploration-focused database will expand as more stream sediment geochemical analyses become available. Eventually the database will include all modern geochemical analyses of stream sediments as well as other geologic materials from Alaska and will be hosted by the DGGs and the USGS.

The Mineral Resources Section published a bedrock geologic map and accompanying report on the Wrangellia terrane in the Talkeetna Mountains and eastern Alaska Range, an area of ongoing exploration for nickel, copper, cobalt, and platinum group elements. Other economic-geology themed reports covered the gold and massive-sulfide mineral occurrences of the Tok River area, and the petrology and REE potential of the Mount Fairplay region. Other reports included geochemical and geochronological data releases tied to ongoing mapping projects (table 5).

### Geophysical Datasets

In 2020, the DGGs received \$500,000 of USGS Earth MRI and \$175,000 of BLM funding to acquire fixed-wing magnetic and radiometric data in the Yukon-Tanana uplands. These data were collected in summer 2021. The Eagle survey, located near Eagle, Alaska, covers 3,757 square miles ([doi.org/10.14509/30755](https://doi.org/10.14509/30755)). The White Mountains survey, just north of Fairbanks, Alaska, covers 5,186 square miles ([doi.org/10.14509/30756](https://doi.org/10.14509/30756)).

The Lower Tanana and Big Delta fixed-wing magnetic and radiometric surveys are delayed until 2022. The DGGs anticipates achieving complete magnetic data coverage of the Yukon-Tanana uplands by fall of 2022. When completed, these surveys will provide full

magnetic data coverage of the Yukon-Tanana uplands, except for Yukon-Charlie Rivers National Preserve. The DGGs's complete collection of modern airborne magnetic, electromagnetic, and radiometric geophysical data are available for download through the DGGs website.

### Alaska Geologic Materials Center

The GMC, curated and operated by the 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, USGS Alaska collections, the former U.S. Bureau of Mines, and other agencies. The GMC archives 75 years' worth of geologic data consisting of energy, mineral, and geologic collections, with an estimated replacement value exceeding \$35 billion. The 100,000-square-foot facility in Anchorage provides a wide range of users (industry, government, academia, and the public) access to samples for identifying new resource prospects and increasing our geologic knowledge of the state. The GMC holds more than 777,000 samples, including 42,998 mineral core boxes from 2,321 drillholes at 290 mineral prospects.

The GMC opened in 2015 and has completed its sixth fiscal year. There were 500 visits to the facility during 2021. This is about one-third of pre-pandemic client traffic, but 25 percent higher than 2020. A database-driven search engine ([maps.dggs.alaska.gov/gmc](https://maps.dggs.alaska.gov/gmc)) allows users to view real-time details of nearly 760,000 public sample items quickly and easily in the GMC's inventory before visiting the facility. This innovative and complex database and online search engine was developed in-house by DGGs staff and continues to serve user needs. There were 11,590 annual requests to GMC web pages.

The GMC's non-destructive scanning project received \$1,290,000 as approved by the state legislature. Expanding the multispectral scanning datasets necessitates programming support for improved web applications, database modifications for the storage and dissemination of large digital geologic datasets, and hardware

upgrades to expand network backbone speeds and to increase storage capacity for very large datasets.

The GMC hosted visits by major and independent oil companies, mineral companies and government researchers operating in the North Slope, Cook Inlet, and statewide regions. Mining industry visits increased for the second consecutive year.

### Alaska Geospatial Office

The Alaska Geospatial Office (AGO) was created in February 2021 to provide strategic oversight of the state's geospatial technology portfolio. AGO advances the use of geospatial technologies as a tool for better decision-making in Alaska, by coordinating statewide geospatial initiatives through the Alaska Geospatial Council (AGC) resulting in cost-effective ways to create, access, and apply geospatial data and technology. Overall, it strives to support existing and future efforts to improve the quality of geospatial data in Alaska through coordination and collaboration with the larger GIS community.

The state's Open Data Geoportal ([gis.data.alaska.gov](https://gis.data.alaska.gov)) provides access to location-based data, maps, and applications, making the state's vast collection of spatial data easier for the public to locate and use. As a one-stop shop for access to government spatial information, this portal reduces time spent surfing through department websites and reduces time agencies spend responding to data requests. AGO continues to coordinate with data managers across the state to develop consistent standards and workflows to improve data quality, access, and management skills, ensuring long-term viability of the state's geospatial data assets.

AGO hosts access points to the new statewide high resolution (50 cm) satellite imagery. The new Alaska Imagery Portal provides access to the most current statewide imagery. AGO launched the portal with an initial 14 TBs of data available as map services. The portal debuted the two statewide imagery layers currently available for the state, the SPOT-5 (completed in 2013)



**Photo 6.** Visitors examine core at the Alaska Geologic Materials Center.

2.5-meter and the newer Alaska High Resolution Imagery 0.5-meter ortho-mosaics (completed in 2020). The imagery is accessible as image map services through the State Open Data Geoportal ([gis.data.alaska.gov](https://gis.data.alaska.gov)).

This year, the AGC added the Coastal & Ocean Technical Working Group (AGC C&O) to support ongoing efforts to map the coastline, nearshore and Exclusive Economic Zone of Alaska. AGC C&O supported the National Oceanic and Atmospheric Administration and the Alaska Mapping Executive Committee in implementing the 2020 Alaska Coastal Mapping Strategy and 2021 Implementation Plan. Major progress includes the collection of topobathymetric lidar at 29 coastal communities, 98,000 miles of bathymetry, 10,000 square miles of high-resolution coastal imagery, and many pilot projects using new equipment or technologies to Alaska. AGC C&O also helped facilitate the 2021 Alaska Coastal Mapping Summit with over 250 registrants.

### DGGS Geologic Information Center

The DGGS's Geologic Information Center developed a centralized sample record management system for the multi-decades worth of field samples, sample descriptions, and other associated data collected by the DGGS. Sample and field station data are now available as an online GIS feature service and available to the public through the GMC inventory catalog ([maps.dggs.alaska.gov/gmc](https://maps.dggs.alaska.gov/gmc)).

# EXPLORATION

Impeded by the continuing COVID-19 pandemic, but buoyed by rising metal prices, exploration spending in Alaska totaled \$273.1 million in 2021, an 87 percent increase from \$145.9 million spent in 2020 (figs. 3 and 4). Alaska paralleled global trends: estimated worldwide exploration budgets increased by 35 percent year-over-year to \$11.2 billion from \$8.3 billion in 2020. The exploration sector recovery was faster than expected and driven by higher metals prices, increased financing activities, and the decline of pandemic-related shutdowns.

To limit the spread of COVID-19 in exploration camps, mines, and neighboring communities, Alaska's mineral industry continued to

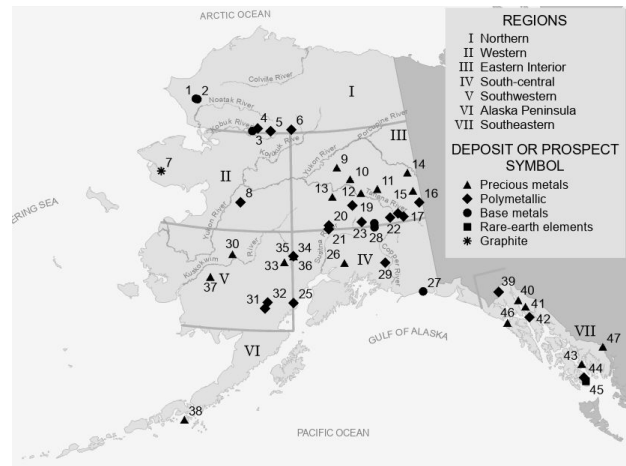


Figure 3. Selected exploration projects in Alaska, 2021.

## Exploration

### I. Northern Region

1. Lik—Solitario Zinc Corp.-Teck Alaska Inc.
2. Anarraaq-Aktigiruaq—Teck Alaska Inc.
3. Bornite—Ambler Metals LLC
4. Arctic—Ambler Metals LLC
5. Sun—Valhalla Metals Inc.
6. Roosevelt—South32 Ltd.

### II. Western Region

7. Graphite Creek—Graphite One Inc.
8. Illinois Creek-Waterpump Creek—Western Alaska Copper & Gold

### III. Eastern Interior Region

9. Tolovana District
  - a Livengood (Money Knob)—International Tower Hill Mines Ltd.
  - b Shorty Creek—Freegold Ventures Ltd.
10. Fairbanks District
  - a Fort Knox and district—Kinross Gold Corp.
  - b Amanita—Avidian Gold Inc.
  - c Golden Summit—Freegold Ventures Ltd.
  - d Grant-Ester-Treasure Creek—Felix Gold Ltd.
11. Goodpaster District
  - a Pogo Mine and Goodpaster—Northern Star Resources Ltd.
  - b 64North Gold—Millrock Resources Inc.-Resolution Minerals Ltd.

- c Tibbs—Tectonic Metals Inc.
- d Carrie Creek—Tectonic Metals Inc.
- e Healy Claims—Kenorlands Minerals Ltd.-Newmont Corp.
12. Richardson Subdistrict
  - a SAM—Koza Ltd.-GAME
  - b Shamrock—Contango ORE Inc.
13. Liberty Bell—Felix Gold Ltd.
14. Seventymile—Tectonic Metals Inc.
15. Napoleon—J2 Metals Inc.
16. Tanacross—Kenorland Minerals Ltd.
17. Manh Choh—Kinross Gold Corp.-Contango ORE Inc.
18. Eagle-Hona—Contango ORE Inc.
19. Red Mountain—White Rock Minerals Ltd.
20. Golden Zone—Avidian Gold Inc.
21. Chulitna—Discovery Alaska Ltd.
22. Delta VMS Project—Agnico Eagle Mines Ltd.
23. Alaska Range—PolarX Ltd.
24. Nikolai-Eureka Zone—Millrock Resources Inc.

### IV. South-central Region

25. Johnson Tract—HighGold Mining Inc.
26. Lucky Shot—Contango ORE Inc.
27. Icy Cape—Alaska Mental Health Trust Land Office
28. Genesis (Tonsina)—New Age Metals Inc.
29. Chisna—Millrock Resources Inc.

### V. Southwestern Region

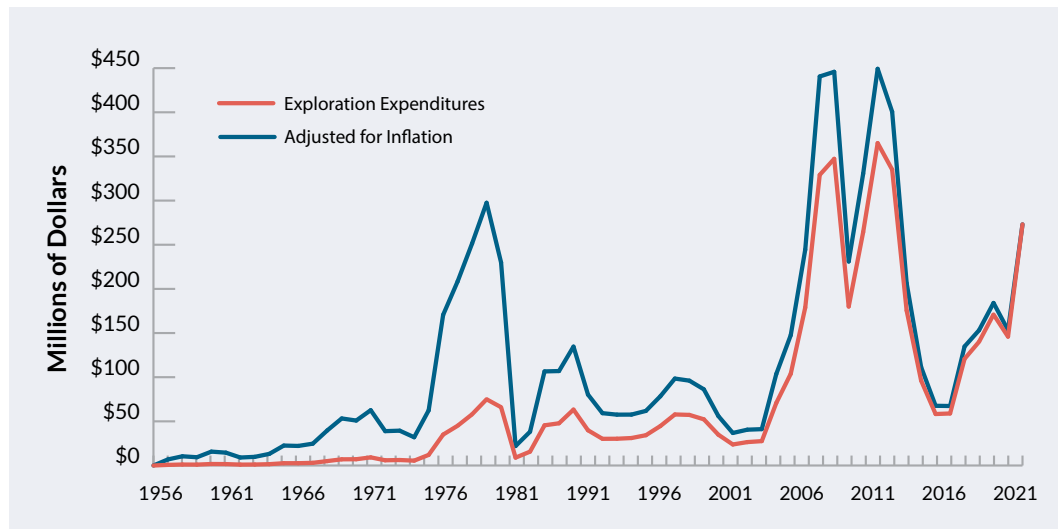
30. Donlin Gold—Donlin Gold LLC
31. Pebble—The Pebble Limited Partnership
32. Groundhog—Lion Copper and Gold Corp.-Chuchuna Minerals Co.
33. Terra—WestMountain Gold Inc.
34. Estelle—Nova Minerals Ltd.
35. Monte Cristo—Ragusa Minerals Ltd.
36. Whistler—GoldMining Inc.
37. Nyac—Calista Corp

### VI. Alaska Peninsula Region

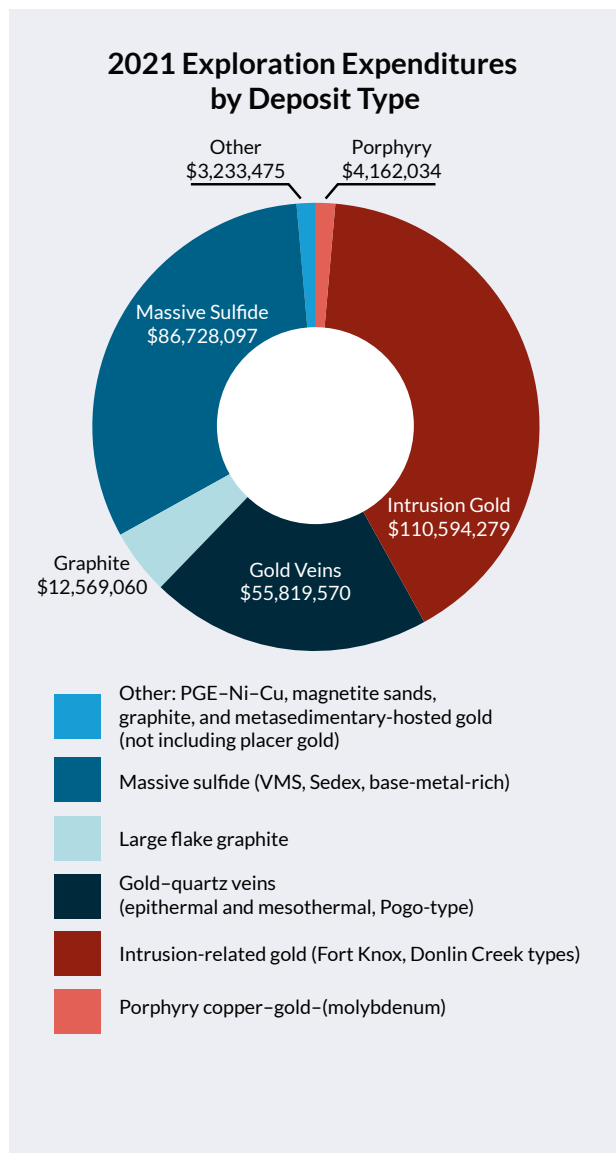
38. Unga—Heliostar Metals Ltd.

### VII. Southeastern Region

39. Palmer—Constantine Metal Resources Ltd.-Dowa Metals & Mining Alaska Ltd.
40. Kensington—Coeur Alaska Inc.
41. Herbert Gold—Grande Portage Resources Ltd.
42. Greens Creek Mine—Hecla Mining Company
43. Helm Bay—Agnico Eagle (USA) Ltd.
44. Niblack—Blackwolf Copper and Gold Ltd.
45. Bokan Mountain—Ucore Rare Metals Inc.
46. Apex-El Nido—Millrock Resources Corp.-Coeur Alaska Inc.
47. Hyder—Blackwolf Copper and Gold Ltd.



**Figure 4.** Alaska mineral exploration expenditures, 1956–2021. Blue line is adjusted for inflation to 2021 dollars.



implement strict COVID-19 protocols that included requiring negative COVID-19 tests for travel, social distancing, encouraging COVID-19 vaccinations, face masks, and sanitization. Many sites contracted a medical service provider to administer rapid COVID-19 tests.

Long delays in receiving geochemical results from analytical labs was a common theme, and a shortage of drillers and equipment was notable for many exploration projects.

Exploration for gold in Alaska surged in 2021, increasing 66 percent over 2020 levels (fig. 5; table 6). Almost 61 percent of Alaska exploration dollars were spent on gold projects, boosted by emerging projects at Estelle and Tibbs Creek, as well as increased exploration at Goodpaster, Donlin Gold, Manh Choh, Golden Summit, Kensington, and Unga, among others. Exploration for base-metal and polymetallic deposits also increased in Alaska, especially for VMS projects.

Eighty-six lode mineral exploration projects, some managed by the same company, reported activity in 2021. Excluding Alaska’s operating mines, 36 projects spent \$1 million or more on exploration. An additional 23 projects each spent

**Figure 5.** Exploration expenditures by deposit type, 2021.

**Table 6.** Reported exploration expenditures in Alaska by commodity, 1981–2021. All 2021 exploration expenditures were reported by the company; no estimates were utilized in the compilation.

	Base metals	Polymetallic <sup>a</sup>	Precious metals <sup>b</sup>	Industrial minerals	Coal and peat	Other <sup>c</sup>	Total
1981	\$ 28,262,200	-	\$ 35,273,200	\$ 10,300,000	\$ 2,341,000	\$ 127,000	\$ 76,303,400
1982	31,757,900	-	10,944,100	-	2,900,000	15,300	45,617,300
1983	9,758,760	-	20,897,555	2,068,300	1,338,454	70,000	34,133,069
1984	4,720,596	-	14,948,554	270,000	2,065,000	279,500	22,283,650
1985	2,397,600	-	6,482,400	-	270,000	-	9,150,000
1986	1,847,660	-	6,107,084	170,000	790,000	-	8,914,744
1987	2,523,350	-	11,743,711	286,000	1,150,000	31,000	15,734,061
1988	1,208,000	-	41,370,600	160,200	2,730,000	-	45,468,800
1989	3,503,000	-	43,205,300	125,000	924,296	5,000	47,762,596
1990	5,282,200	-	57,185,394	370,000	321,000	97,000	63,255,594
1991	4,789,500	-	34,422,039	92,000	603,000	2,000	39,908,539
1992	1,116,000	\$ 3,560,000	25,083,000	25,000	425,000	0	30,209,000
1993	910,000	5,676,743	23,382,246	163,500	0	125,000	30,257,489
1994	600,000	8,099,054	18,815,560	225,000	2,554,000	810,000	31,103,614
1995	2,770,000	10,550,000	20,883,100	100,000	0	3,000	34,306,100
1996	1,100,000	11,983,364	31,238,600	400,000	0	0	44,721,964
1997	1,700,000	22,347,000	32,960,500	80,000	720,000	0	57,807,500
1998	1,000,000	13,727,000	42,441,000	12,000	87,000	0	57,267,000
1999	3,869,000	3,168,000	44,891,000	1,000	0	410,000	52,339,000
2000	8,545,000	3,933,000	21,579,000	58,500	0	736,100	34,851,600
2001	4,810,000	1,977,000	15,820,000	50,000	10,000	1,106,000	23,773,000
2002	1,700,000	5,162,000	17,342,000	185,000	0	2,113,000	26,502,000
2003	262,000	7,081,000	19,726,000	0	0	533,000	27,602,000
2004	3,100,000	40,237,000	26,954,000	213,000	50,000	258,000	70,812,000
2005	1,764,000	54,271,000	46,255,000	142,000	0	1,463,000	103,895,000
2006	5,069,000	81,073,000	89,793,000	20,000	2,394,000	580,000	178,929,000
2007	38,888,000	123,487,500	155,601,400	42,500	7,675,000	3,447,000	329,141,400
2008	30,116,000	163,030,000	134,885,000	0	0	19,238,000	347,269,000
2009	3,862,715	85,871,529	84,020,531	17,850	0	6,193,518	179,966,143
2010	6,392,519	122,955,321	125,364,382	19,000	6,520,200	3,104,199	264,355,621
2011	7,730,891	160,880,974	186,255,005	-	3,250,000	6,962,325	365,079,195
2012	18,161,211	150,339,009	152,444,311	-	W	14,129,838	335,074,369
2013	8,122,810	103,524,782	60,977,949	22,762	W	2,840,713	175,489,016
2014	8,310,433	29,836,240	51,759,541	32,221	W	6,300,413	96,238,848
2015	6,199,064	25,171,955	26,907,877	-	-	-	58,278,896
2016	7,820,283	25,295,705	24,857,804	-	-	912,510	58,886,302
2017	16,207,528	48,325,468	53,605,626	-	W	2,669,363	120,807,985
2018	11,932,106	57,693,015	66,168,235	-	W	4,278,600	140,071,956
2019	16,109,000	80,523,572	69,023,716	-	W	5,320,390	170,976,678
2020	-	43,517,449	100,223,594	10,000	-	2,106,830	145,857,873
2021	1,271,972	89,798,692	166,413,849	-	-	15,622,002	273,106,515
<b>Total</b>	<b>\$ 315,490,298</b>	<b>\$ 1,583,096,372</b>	<b>\$ 2,218,252,763</b>	<b>\$ 15,660,833</b>	<b>\$ 39,117,950</b>	<b>\$ 101,889,601</b>	<b>\$ 4,273,507,817</b>

<sup>a</sup>Polymetallic deposits considered a separate category for the first time in 1992.

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

<sup>c</sup>Includes rare-earth elements, magnetite sands, graphite, and other common deposit types.

N/A = Not available

- = Not reported

W = Withheld; data included in "Other" column

\$100,000 or more. The eastern Interior region saw the most exploration, with more than \$96 million spent during 2021, mostly on gold-related projects. Southwest Alaska had almost \$62 million spending, mostly on gold-related projects. The northern region saw significant spending on volcanogenic and sediment-hosted polymetallic massive sulfide deposits, with expenditures totaling \$46 million. Exploration expenditures for gold vein and VMS deposits in Southeast Alaska were more than \$33 million.

Alaska is perceived as an attractive place to explore for minerals. In 2021, the Fraser Institute annual survey of mining companies ranked Alaska fourth out of 84 worldwide jurisdictions for overall investment attractiveness by mining and exploration companies, which considers geologic potential as well as government policy factors that affect exploration investment. Alaska also ranked first in security and ninth for taxation regime.

Alaska ranked second on the best practices mineral potential index. This index highlights

#### ALASKA'S RANKINGS

out of 84 global mining jurisdictions<sup>2</sup>

4<sup>th</sup>

for overall investment attractiveness

2<sup>nd</sup>

for mineral potential

a region's geology and potential to host mineral deposits. Alaska was perceived to have mining-friendly regulatory and fiscal policies, as well as attractive geological databases. Seventy percent of

survey respondents for Alaska indicated that timelines for permit-approval decisions were met between 80 and 100 percent of the time—the highest share of all surveyed jurisdictions.

The total area of the state covered by mining claims and prospecting sites in 2021 increased by almost six percent to over 4.3 million acres (table 7). Total area of state mining claims increased almost six percent to 4.2 million acres, while total federal mining claims increased eight percent to 136,340 acres. The total number of active 40-acre claims increased by three percent while the number of 160-acre claims increased by six percent.

Inventory of state prospecting sites, which expire two years after initial staking, did not change.

## Northern Region

### Aṅarraaq–Aktigirūq

Teck Alaska Inc. resumed exploration at their Aṅarraaq deposit and Aktigirūq prospect, which lie about eight miles northwest of the Red Dog Mine. The Aṅarraaq deposit holds an inferred resource of 21 million tons grading 14.4 percent zinc, 4.2 percent lead, and 2.13 ounces of silver per ton (app. D). Preliminary exploration of the nearby Aktigirūq target suggests a potential resource in the range of 88–165 million tons of mineralization grading 16–18 percent combined zinc plus lead. If confirmed, Aktigirūq 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.

Exploration during 2021 consisted of diamond drilling, geophysical surveys, surface sampling, archaeological studies, and environmental studies. Diamond core drilling was contracted through Tuuq Drilling and Major Drilling. Two EF-75 drill rigs drilled a total of 4,800 feet of core in two holes. Archaeological mapping of proposed drill sites and mapping of wetland areas preceded the drilling. The field programs and drilling campaign were supported by two A-STAR B3 helicopters contracted from Heliqwest International.

Induced Polarization (IP) geophysical surveys were completed with a total of 1.1 line-miles surveyed on the Delong tenure as extensions of IP survey performed across Lik. A magnetotellurics (MT) geophysical survey was completed between June 26 and August 10, 2021, with 2.5 line-miles surveyed. A total of 80 soil samples were collected between June 15 and August 7.

Work performed on the TK claims included geophysical surveying, rock chip sampling, and mapping over the claims. IP geophysical surveys, contracted through DIAS Geophysical, covered a total of 6.87 line-miles.



**Table 7.** Summary of claim activity, 1991–2021. The figures in this table may change as data are reviewed and updated.

Year <sup>a</sup>	State Claims				State Prospecting Sites (160 acres)		Federal Claims (20 acre sites)	
	New (Active) 40 acre <sup>b</sup>	New (Active) 160 acre	Total (Active) 40 acre <sup>b</sup>	Total (Active) 160 acre	New	Total	New	Total
1991	3,277	0	37,862	0	747	1,723	1,299	23,222
1992	2,640	0	36,250	0	454	1,472	695	20,254
1993	2,120	0	34,340	0	1,412	2,259	601	9,298
1994	4,057	0	34,400	0	802	2,378	341	8,495
1995	4,512	0	30,464	0	1,030	2,725	376	7,766
1996	9,489	0	36,602	0	2,082	3,687	681	9,346
1997	8,678	0	42,836	0	2,480	5,305	1,872	11,320
1998	9,786	0	49,816	0	3,194	7,148	427	11,033
1999	11,978	0	56,107	0	1,755	7,600	308	10,176
2000	4,560	614	54,393	614	1,143	5,675	523	7,805
2001	858	907	49,627	1,503	27	3,091	464	8,248
2002	745	826	44,056	2,179	61	2,138	261	8,100
2003	856	2,603	38,076	4,387	101	1,857	676	8,424
2004	1,070	3,533	34,380	7,719	59	1,484	66	8,313
2005	806	4,502	34,066	11,551	128	1,612	411	7,826
2006	1,111	5,747	33,864	16,249	103	1,646	457	8,068
2007	576	6,031	31,305	20,208	57	1,625	933	8,872
2008	1,333	2,565	23,033	13,519	24	651	3,001	11,732
2009	1,142	2,793	24,340	16,381	40	335	1,057	10,431
2010	1,446	6,132	24,805	20,389	88	441	332	8,413
2011	1,932	4,893	24,319	21,970	180	273	284	8,438
2012	1,638	3,478	24,673	20,810	202	409	632	—
2013	1,622	2,155	24,883	17,347	28	209	289	6,916
2014	1,219	677	25,479	15,250	19	197	69	6,003
2015	1,014	711	26,493	15,961	21	36	71	6,074
2016	1,164	893	21,303	9,887	21	31	37	5,656
2017	1,713	3,453	22,175	12,074	44	85	695	6,259
2018	1,083	2,319	19,757	17,948	23	113	87	6,248
2019	1,063	3,508	19,245	16,303	90	131	90	6,216
2020	1,357	3,613	16,721	19,880	577	586	135	6,312
2021	552	2,384	17,290	21,152	5	586	712	6,817

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.

<sup>a</sup>After 2010, State claim and prospecting site totals are not directly comparable to previous years. After 2016, new State prospecting sites and total prospecting sites are not directly comparable to previous years. Claim totals comprise Mining Claims (including "River Bottom Navigable"

subtype) and Leasehold Locations whose claimants filed an Annual Affidavit of Labor, and claims initiated on State-selected land. There were 1,561 "at-risk" 40-acre claims and 1,505 "at-risk" 160-acre claims on State-selected land in 2021. There were 11 new offshore prospecting permit applications (up to 2,560 acres) in 2021, with no approval of those permits in 2021..

<sup>b</sup>Includes claim fractions varying from 1 to 39 acres.  
— = Not reported

## Lik

Teck and 50-percent-co-owner Solitario Zinc Corp. conducted limited exploration at the Lik zinc–lead–silver sediment-hosted massive sulfide deposit northwest of Red Dog Mine. Lik hosts two massive sulfide deposits with a total indicated and inferred resource of 25.85 million tons, grading 8.23 percent zinc, 2.72 percent lead, and 1.16 ounces of silver per ton (app. D).

One drill pad was constructed at the Lik prospect to be utilized for drilling in 2022. Archaeological mapping of proposed drill sites and mapping of wetland areas was completed prior to pad construction. IP geophysical surveys were completed in the area, with a total of 5.1 line-miles surveyed. Analysis of the geophysical survey results suggested that the mineralized horizon hosting the Lik deposit flattens to the west and could be at drillable depths in a valley floor situated approximately two miles to the west. A total of 258 soil samples were also collected.

## Ambler Mining District Upper Kobuk Mineral Projects

The Upper Kobuk Mineral Projects (UKMP) is located within the Ambler Mining District in the southern Brooks Range and hosts world-class polymetallic VMS deposits (including Arctic) that contain copper, zinc, lead, gold, and silver, and carbonate-replacement deposits (including Bornite) that host high-grade copper and cobalt mineralization. The UKMP is operated by Ambler Metals LLC, a 50/50 joint venture formed in February 2020 between Trilogy Metals Inc. and South32 Limited.

Exploration conducted from mid-May to early October was challenged by record precipitation events and intense industry-wide competition for diamond drilling labor. The project followed strict COVID-19 testing protocols and administered more than 1,110 COVID-19 tests. The program resulted in only one positive COVID-19 case in camp, on the last day of the field program.

The 2021 UKMP exploration field program was active at the Arctic deposit and in the Bornite

and the Ambler VMS belts. Ambler Metals employed, on average, approximately 70 people at site and approximately 120 seasonal employees during the field season. More than 50 percent of those employees consisted of NANA and Doyon shareholders. The Bornite man camp that supports UKMP exploration opened on May 5, 2021, and closed on October 15, 2021.

## Arctic

Trilogy Metals Inc. announced feasibility study (FS) results for the Arctic deposit (app. D) in 2020, demonstrating the technical and economic viability of establishing a conventional open-pit copper–zinc–lead–silver–gold mine and mill complex operating at 11,000 tons per day over a 12-year mine life. The FS forecasts an average annual payable production to be more than 155 million pounds of copper, 192 million pounds of zinc, 32 million pounds of lead, 32,165 ounces of gold, and 3.4 million ounces of silver. Total life-of-mine production is projected at 1.9 billion pounds of copper, 2.3 billion pounds of zinc, 388 million pounds of lead, 386 thousand ounces of gold, and 40.6 million ounces of silver.

The 2021 Arctic drill program, which consisted of 18 core holes totaling 13,553 feet, was designed to convert part of the resources from the indicated category to the measured category, provide material for metallurgical testing, and collect geotechnical information. Of the 18 holes drilled, eight were for the geotechnical program. The remaining 10 drill holes were part of the infill and metallurgical program, three of which also provided hydrologic data. More than 4.4 tons of mineralized material for metallurgical testing were collected from drill core to support variability test work and pilot plant work.

Within the Arctic deposit, mineralization occurs as stratiform semi-massive sulfide to massive sulfide beds within primarily graphitic chlorite schists and fine-grained quartz schists. The sulfide beds average 13 feet in thickness but vary from less than 3 feet up to as much as 65 feet in thickness. All reported intervals are thought to be close to the

true width and therefore represent the actual thickness of mineralization.

Semi-massive to massive mineralization at the Arctic deposit consists of chalcopyrite, sphalerite, pyrite, with lesser galena, trace native copper, bornite, chalcocite, and covellite, variable pyrrhotite. Barite content varies widely within and surrounding the sulfide layers. Gangue minerals include quartz, chlorite, talc, and calcite.

Significant highlights from the 2021 drilling at the Arctic deposit include drill holes AR21-0176 and AR21-0190. Other significant drill hole intercepts are listed in table 8. Drill hole AR21-0176, which contained 65.3 feet of 11.76 percent copper equivalent (a grade-times-thickness of 768 percent-feet), represents the third highest ever grade-thickness intersect out of 178 holes drilled to date. The interval averaged 6.75 percent copper, 7.59 percent zinc, 1.68 percent lead, 0.037 ounces of gold per ton, and 2.84 ounces of silver per ton percent. Mineralization within the high-grade portions of drill hole AR21-0176 consists of 20–40 percent chalcopyrite, 8–15 percent sphalerite, 2–5 percent galena, and 10–20 percent pyrite. Barite is also present between 10 and 18 percent. All percentages are based off the visual estimations in the core.

Hole AR21-0190 intersected six mineralized intervals, including 64.0 feet of 4.75 percent copper, 7.83 percent zinc, 2.04 percent lead, 0.033 ounces of gold per ton, and 2.57 ounces of silver per ton for a copper equivalent grade of 9.81 percent, and 6.8 feet of 10.18 percent copper, 9.46 percent zinc, 1.53 percent lead, 0.132 ounces of gold per ton, and 4.06 ounces of silver per ton for a copper equivalent grade of 18.26 percent.

Ambler Metals engaged Stantec in the fall of 2021 to conduct a permitting preparedness review for the Arctic project. After a thorough review, Ambler Metals proceeded making the recommended changes to the permitting package and are expected to file the permitting application, which will start the formal permitting

process, with the U.S. Army Corps of Engineers (USACE) in 2022.

### **Bornite**

Bornite is a carbonate-hosted copper deposit with associated cobalt and germanium (app. D). Known mineralization consists of three stratabound copper bodies, or 'reefs' that plunge northeast at about -25 degrees. These include the Lower and Upper reefs, referred to as the Ruby zone, with both in-pit and below-pit resources. Approximately 800 feet southeast of the Ruby zone is the South Reef zone, discovered in 2011. South Reef's two-percent copper shell starts at about 1,300 feet below surface and plunges to the northeast at about -25 degrees to approximately 3,300 feet below surface. The true thickness of the resource at South Reef is variable, ranging from 16 feet to over 125 feet and averages about 60 feet.

The geology of the Bornite resource area is composed of alternating intervals of carbonate rocks (limestone and dolostone) and calcareous phyllite. Limestone transitions laterally into dolostone near zones of mineralization and is hydrothermally altered. Copper mineralization at Bornite is comprised of chalcopyrite, bornite, and chalcocite as stringers, veinlets, and breccia fillings distributed in stacked, roughly stratabound zones exploiting favorable stratigraphy.

Cobalt mineralization at Bornite is comprised of cobaltiferous pyrite within and enveloping the copper mineralized zones and carrollite and cobaltite directly associated with copper-bearing minerals.

During the 2021 field season, Ambler Metals conducted field mapping, including trenching in the Cosmos Hills and relogging of Bornite drill core. The potential for additional deposits was advanced with a new interpretation of the carbonate sequence at Bornite and an improved structural understanding of the Cosmos Hills. The Bornite sequence is now interpreted as a tectonized "normal" carbonate slope deposit that consists of calcitic material (lime mud)

**Table 8.** 2021 Significant Arctic Project drilling results.

Hole	From (ft)	To(ft)	Length (ft)	Cu (%)	Zn (%)	Pb (%)	Ag (opt)	Au (opt)
AR21-0173	362.66	375.03	12.37	2.15	0.87	0.34	2.42	0.02
AR21-0174	278.81	312.01	33.20	3.21	6.14	1.46	1.45	0.02
AR21-0175	235.99	317.81	81.82	1.85	2.96	0.57	0.79	0.01
including	268.04	286.48	18.44	4.94	10.57	1.71	1.72	0.01
AR21-0176	419.82	485.14	65.32	6.75	7.59	1.68	2.84	0.04
	540.19	562.37	22.18	1.55	6.61	1.58	0.60	0.00
	605.28	646.00	40.72	2.88	3.29	0.88	1.58	0.02
AR21-0178	579.72	594.82	15.09	3.53	1.37	0.10	0.54	0.00
AR21-0179	185.30	205.81	20.51	2.02	3.19	1.03	1.21	0.03
AR21-0180	476.77	505.97	29.20	2.20	2.55	0.46	1.01	0.01
	541.31	564.50	23.20	2.38	1.27	0.24	0.53	0.00
AR21-0181	373.16	399.77	26.61	1.95	1.82	0.36	0.94	0.01
	431.99	474.97	42.98	4.42	7.91	1.13	2.11	0.02
	485.01	495.24	10.24	3.35	5.07	1.27	2.30	0.03
	508.37	591.80	83.43	2.35	4.56	1.09	0.60	0.00
	613.98	634.91	20.93	2.77	7.14	0.94	1.26	0.01
	660.43	734.45	74.02	2.60	5.60	1.19	2.60	0.02
AR21-0182	391.27	481.99	90.72	2.75	2.65	0.46	1.25	0.02
	508.89	544.69	35.79	3.31	8.22	1.78	2.07	0.02
	666.80	700.46	33.66	1.98	0.91	0.10	0.77	0.01
AR21-0183	659.12	682.41	23.29	7.10	6.51	0.38	1.61	0.01
AR21-0184	418.77	466.21	47.44	1.96	5.57	1.71	1.49	0.02
	500.10	513.85	13.75	1.90	5.42	1.14	1.45	0.02
AR21-0185	399.74	424.25	24.51	4.28	6.71	1.26	1.70	0.01
AR21-0186	358.96	391.99	33.04	3.53	2.31	0.38	1.73	0.02
	409.09	478.58	69.49	2.74	3.45	0.89	1.31	0.03
	505.05	516.67	11.61	0.82	7.43	3.08	3.55	0.05
	583.79	598.85	15.06	1.68	7.89	1.13	1.09	0.00
	635.07	656.99	21.92	3.18	3.24	0.78	2.01	0.02
AR21-0187	275.59	298.00	22.41	6.57	9.60	1.58	2.54	0.02
	404.17	408.46	4.30	6.18	4.12	0.47	1.25	0.00
AR21-0188	437.01	468.01	31.00	3.00	0.91	0.16	0.55	0.00
	719.42	742.95	23.52	1.61	2.26	0.17	0.48	0.00
AR21-0189	169.42	203.61	34.19	6.78	13.14	2.36	3.00	0.01
AR21-0190	440.42	447.24	6.82	10.18	9.46	1.53	4.06	0.13
	463.02	527.00	63.98	4.75	7.83	2.04	2.57	0.03
	529.72	543.01	13.29	3.02	4.03	0.19	1.28	0.01
	560.17	575.75	15.58	4.28	5.06	0.31	1.19	0.01
	608.53	654.10	45.57	3.46	2.86	0.10	0.75	0.01

derived from a nearby shallow-marine source area, interlayered with variable amounts of terrigenous mud. Importantly, superimposed on the active limestone slope system is the local presence of dolostone-clast conglomerate that are likely derived from subaqueous horst blocks of pre-existing older dolostone that shed into the slope limestone system. The fault scarp(s) that shed dolostone clasts were probably part of a seafloor paleo-topographic system that developed during regional extension and associated fault-mediated syn-depositional subsidence.

Proximal-distal relationships may help locate structures that delivered mineralizing fluids because dolostone conglomerates dominate the stratigraphy in the mineralized areas of the Bornite deposit. Massive sulfide distribution and characteristics suggest that syn-sedimentary faults associated with dolostone-clast conglomerates may have later served as conduits for mineralizing fluids. A better understanding of the configuration of the sedimentary system was recommended as its characteristics could assist in future exploration looking for other Bornite-style deposits.

The 2021 exploration program in the area surrounding the Bornite deposit included soil sampling and drilling. Approximately 1,800 soil samples were collected and analyzed from the Cosmos Hills. Drilling outlined four areas for future drilling. Drill hole RC21-267, located about one mile west of Bornite and about 0.6 miles along the projected northeastern trend of mineralization at the Pardner Hill prospect, encountered low-grade copper in Bornite sequence carbonates.

Another drillhole in the general Bornite area was drilled in the Ambler Lowlands, a 6-mile-wide, virtually unexplored, glaciated valley separating the Arctic and Bornite prospects. Hole ALL21-001 was designed to redrill one of the two holes drilled in the valley, NANA-1, drilled in 1974, which historical drill logs show intersected dolomitized carbonate and carbonate breccia similar to the carbonates that host the Bornite deposit. Unfortunately, hole ALL21-001 was lost

at a depth of 984 feet, above the expected depth of the Bornite sequence.

### **District-Wide Exploration**

Exploration by Ambler Metals in the broader Ambler Mining District included drilling, geologic mapping, and geochemical soil sampling. Regional drilling focused on near Arctic (Arctic Hub) exploration targets, with the goal of discovering nearby copper-rich satellite deposits within a two-to-three-mile radius of the Arctic deposit.

Drilling was completed at the Southeast Arctic, East Arctic, and Snow prospects, but no results were reported. A total of eight holes were completed, including the two drill holes in the Cosmos Hills, totaling 10,479 feet. Geologic mapping was conducted at the Snow, DH, Cliff, Bud-Sunshine, West Dead Creek, Dead Creek, Pipe, Center of the Universe, Nora, BT, and Mo prospects, and in Jackass Creek (between the DH and Cliff prospects). Soil sampling was also conducted at selected sites throughout the Ambler Mineral Belt to follow-up on previous anomalous geochemical results and to investigate geophysical anomalies that were identified during the 2019 airborne versatile time domain electromagnetic (VTEM) survey.

### **Ambler Industrial Access Road**

The Ambler Access Project (AAP), formerly referred to as the Ambler Mining District Industrial Access Project, or Ambler Road, is being executed by the AIDEA to provide future road access to the mineral resources of the Ambler Mining District. The AIDEA received a Joint Record of Decision (JROD) from the BLM in 2020 for a proposed 211-mile industrial access road and the USACE issued a Section 404 permit. The AIDEA signed Right-of-Ways agreements for the AAP with the BLM and the NPS on January 6, 2021. In February 2021, the Ambler Access Development Agreement was signed between the AIDEA and Ambler Metals. This agreement formed a 50/50 partnership, with Ambler Metals contributing 50 percent of the funding, up to

\$35M, until December 31, 2024, to complete feasibility and permitting work for AAP.

A land access agreement was executed with Doyon Regional Corporation on April 14, 2021. A similar land access agreement was executed with NANA Regional Corporation on September 14, 2021. The AIDEA also entered into access and right-of-way agreements with the NPS and the BLM. In October 2021, the Northwest Arctic Borough Assembly passed a resolution in support of the Ambler Access Project. A subsistence advisory committee and a workforce development working group were established in 2021.

The 2021 AAP work program was abridged and approved for implementation by the BLM in early July. The budgeted \$13 million program focused on cultural heritage, but also included aquatic habitat studies and geotechnical work. Approximately 40 cultural heritage sites, approximately 691 acres, along the Ambler Access Road were surveyed and completed. One known Alaska Heritage Resource Survey site boundary was documented within the direct area of potential effect and eight new Alaska Heritage Resource Survey sites were identified. Fish habitat data were collected at 22 sites. Hydraulic and hydrology reconnaissance surveys were conducted at ten potential bridge locations.

Legal proceedings on the JROD litigation on the AAP continued throughout the year. NANA was granted intervenor status in both lawsuits, along with Ambler Metals and the State of Alaska.

### Sun

Valhalla Metals Inc.'s Sun property includes the VMS Sun deposit, with a 11.8-million-ton polymetallic resource (app. D) and several other prospects and targets. In September 2021, Valhalla staked 162 additional 160-acre mining claims to the north, south, and east of the original 230 contiguous Sun block of claims, which brought the current Sun claim block to 392 claims that cover 62,720 acres.

A soil survey and general prospecting, including rock sampling, were conducted at the

Sun property within the Western Anomaly area in August and September. A total of 885 soil samples were collected, along with lithologic chips from the soil pits. Geochemical results were not released from this work. Additional work included two-dimensional and three-dimensional data modeling.

Valhalla Metals Inc. announced a tentative agreement on November 29 that SolidusGold Inc. would acquire Valhalla through an exchange of shares that would result in current Valhalla shareholders owning 80 percent of the resulting company shares, with Solidus shareholders owning the remaining 20 percent. A definitive agreement on the proposed Valhalla-SolidusGold merger was expected by the end of the year. SolidusGold contracted an updated technical report on the Sun property, including updating a Canadian NI 43-101 compliant resource on the Sun deposit, to be completed in 2022.

### Smucker

The Smucker deposit is located on the western edge of the Ambler Mining District in the southern Brooks Range and contains significant copper, zinc, lead, silver, and gold mineralization in a stratabound VMS deposit (app. D). The Smucker claimblock is held by Teck Resources Inc., and Valhalla Mining LLC also staked mining claims in the immediate area.

Valhalla Metals Inc.'s interest in the Smucker Property is subject to an ongoing dispute between Teck, Valhalla Mining, and the DNR. In November 2018, Teck and the DNR notified Valhalla Mining that 11 of the 58 mineral claims comprising the Smucker property were invalid to the extent of those claims overlapped the old Teck claims block at Smucker.

Valhalla Mining succeeded in its claims to quiet title to the disputed mining claims in April 2021 at the Alaska Superior Court. The court's decision was appealed to the Alaska Supreme Court by Teck and the DNR on April 27, 2021. A final resolution of the appeal is expected in late 2022 or early 2023.

## Roosevelt

South32 USA Exploration Inc. conducted work on the eastern extension of the Ambler Belt at the Roosevelt prospect. Massive sulfide mineralization was discovered at Roosevelt Creek by Anaconda Alaska in the late 1970s. The 2021 work program followed acquisition of satellite-based ASTER over the entire property at 3.9-foot resolution, and WorldView-3 (202 square miles at 6.6-foot resolution) imagery for alteration mapping.

Geological mapping was conducted at a 1:5,000 scale over nine prospect areas identified from the 2020 VTEM geophysical survey (Roosevelt, Franklin, Red, Jones, Grybeck, Malamute, Gilroy, King, and Ipnek). Sampling included the collection of 280 surface rock grab samples, 3,574 soil samples, and 74 stream sediment samples for geochemical analysis, as well as the collection of 183 rocks samples for whole-rock lithochemistry, 130 rock samples for petrography, and 21 rock samples for geochronology.

## Ambler Belt Extensions

Trilogy Metals Inc. expanded its footprint in the Ambler VMS Belt in 2021 by staking three blocks of claims outside of the UKMP. Preliminary reconnaissance of the claims was conducted during 10 days in August to collect rock and stream sediment samples.

The West Kobuk claims cover 23,680 acres abutting the western end of the UKMP and along the projection of the Ambler schist belt. The Helpmejack claims cover 19,520 acres along a 7.5-mile strike length of Ambler schist belt between the UKMP and the Roosevelt project. The USGS mapped Ambler belt metavolcanics and metasediments in the Helpmejack area, but the area received little exploration despite stream sediment samples collected in the 1970's having anomalous levels of copper and zinc. Trilogy's fieldwork identified gossanous metavolcanics exposed along a stream for over 80 feet.

The Malamute claims cover 12,480 acres on the south side of a 5-mile-long east-west valley immediately north of the west end of the

Roosevelt property. Mapped by the USGS as undifferentiated metasediments and metavolcanics, the area covers six adjacent drainages with high cobalt and elevated copper in stream sediment samples collected by the DGGs between 1977 and 1982. Trilogy visited the six drainages and resampled the anomalous streams.

## Chandalar District

Goldrich Mining Co. performed reclamation work on the Chandalar gold property during 2021. Goldrich also released an independent initial assessment report for placer gold deposits on the property. The Little Squaw Creek placer deposit has a measured and indicated resource of 138,000 ounces of placer gold, totaling 120,000 ounces of refined gold, as well as an inferred resource of 19,000 ounces of placer gold, totaling 17,000 ounces of refined gold. The measured and indicated gold resource grades 0.0285 ounces per bank cubic yard. Placer gold from Little Squaw Creek deposits has historically averaged 840 fineness.

## Western Region

### Graphite Creek

The advanced-exploration stage Graphite Creek project, located 34 miles north of Nome, hosts the U.S.'s largest large-flake graphite deposit. Graphite One Inc. made progress on a prefeasibility study (PFS) and environmental baseline work. The PFS will address all aspects of a production-scale processing flow sheet that includes primary beneficiation of graphite material to the concentrate stage and secondary processing of graphite concentrate to demonstrate the full portfolio of finished products.

A new Executive Order (EO) issued by U.S. President Biden on February 24, 2021, aimed at strengthening critical U.S. supply chains, identified three technology sectors as critical supply chains: advanced semiconductors, high-capacity batteries, including Electric Vehicle (EV) batteries, and pharmaceuticals. The EO also identified "critical minerals and other... strategic materials" as a fourth supply chain,

essential to technology manufacturing and the Defense Industrial Base. The new EO follows the designation of the Graphite Creek project as a High-Priority Infrastructure Project in both the renewable energy and manufacturing sectors by the U.S. Government's Federal Permitting Improvement Steering Committee. The High-Priority designation allows Graphite One to list on the U.S. Government's Federal Permitting Dashboard, which ensures federal agencies coordinate their project review authorities, resulting in a more efficient process with more transparency for state agencies and the public.

A seasonal remote camp was built at the Graphite Creek site. The field program began in June and was completed in mid-October. The field program included infill and step out core drilling in the resource area and additional core and sonic drilling for geotechnical data collection in the proposed mill site and dry tailings/waste rock storage areas. Resource drilling and exploration has only covered 20 percent of the projected graphite mineralization trend. Other work included access route engineering, surface water and groundwater hydrology studies, wetlands mapping and aquatic life surveys.

The 2021 program included 6,732 feet of drilling, with 5,561 feet of HQ core drilling and 1,171 feet of sonic drilling. Results from the eight-hole core drilling program completed in the resource area are expected to be released in early 2022. However, all 2021 drill holes encountered visible graphitic mineralization over wide intervals consistent with previous drilling results.

Additional core drilling was completed to collect detailed geotechnical information for open pit and mills site engineering, and for groundwater investigations. The five sonic holes completed in the dry tailings/waste rock storage area will provide detailed geotechnical information to advance the engineering of these facilities. The drill program will generate additional information to update the resource model and provide technical data for the project's FS expected to be initiated in 2022.

The company's PFS is scheduled for release in 2022. Design of the mine, mine facilities and infrastructure, primary processing, and secondary (product) processing and infrastructure is ongoing and in the final review stage.

Metallurgical test work was completed. Research and development work with the +100-mesh fraction of purified Graphite Creek PFS material successfully produced synthetic diamonds suitable for use in cutting tool applications. A sample of +80 mesh graphite from Graphite Creek was tested by NAVAIR's Naval Air Warfare Center Weapons Division at China Lake, California, and successfully extinguished Class B fires in accordance with U.S. military specification standards.

Project updates to local communities and interaction with a subsistence advisory council were ongoing.

### **Illinois Creek**

Western Alaska Copper & Gold Inc. continued exploration of the Illinois Creek property located 55 miles south of Galena in western Alaska. The Illinois Creek property hosts the past-producing Illinois Creek Mine, the Round Top copper porphyry prospect, the Waterpump Creek carbonate-replacement prospect, the Honker gold prospect, and other prospects. New information added to the mineral resource base of the property (app. D).

Western Alaska Copper & Gold Inc. announced mineral resource estimates for the Illinois Creek property. The Illinois Creek deposit is estimated to contain 8.2 million tons of mineral resources in the Indicated category at a grade of 0.03 ounces of gold per ton and 0.96 ounces of silver per ton plus 3.4 million tons of mineral resources in the Inferred category at an average grade of 0.03 ounces of gold per ton and 1.05 ounces of silver per ton. Indicated resources total 234,000 ounces of gold, 7,800,000 ounces of silver, and 28 million pounds of copper. Preliminary metallurgical work indicates that the highly oxidized rocks are amenable to relatively



low-cost leaching extraction of gold and silver using cyanide solutions.

A leach pad area on the property contains a volume of mineralized material that was stacked during previous mining activities and leached intermittently from 1979 through mine closure. The leach pad is estimated to contain 1.4 million tons of mineral resources in the Indicated category at a grade of 0.01 ounces of gold per ton and 1.28 ounces of silver per ton and 167,500 tons of mineral resources in the Inferred category at a grade of 0.01 ounces of gold per ton and 1.26 ounces of silver per ton. The contained metal for the in-situ and leach components of the Illinois Creek Mine is 357,000 ounces of gold and 13.4 million ounces of silver.

During the summer of 2021, Western Alaska completed a total of 25 drill holes on the Illinois Creek project for approximately 7,650 feet at four distinct target areas. Nine drill holes totaling 2,792 feet of drilling were completed at Waterpump Creek, targeting shallow high-grade oxide mineralization and deeper high-grade sulfide carbonate replacement mineralization. Eight holes totaling 2,469 feet were completed on the extensions of the Illinois Creek oxide gold-silver-copper deposit. Six holes at the Honker intermediate sulfidation gold vein swarm target totaled 2,088 feet. Two holes were also drilled at the Last Hurrah carbonate replacement deposit (CRD) prospect.

Much of Western Alaska's 2021 exploration focused on drilling manto-style CRD mineralization at the Waterpump Creek prospect, which hosts 166,000 tons of historical resource averaging 8.61 ounces of silver per ton, 16.1 percent lead, and 5.5 percent zinc, based on 58 holes historically drilled by Anaconda Minerals Company and Novagold Resources Inc. Mineralization at Waterpump Creek occurs as a massive sulfide replacement of hosting carbonate rock dipping gently to the east.

Highlights from the 2021 drilling program include 54.8 feet (51.5 feet true-thickness) of

oxide mineralization averaging 7.48 ounces of silver per ton, 0.7 percent zinc, and 6.4 percent lead from a depth of 76.1 feet in hole WPC21-02; and multiple intercepts in hole WPC21-03, with 4.9 feet (4.6 feet true-thickness) averaging 39.0 ounces of silver per ton from a depth of 167.0 feet and 31.8 feet (29.9 feet true-thickness) averaging 2.60 ounces of silver per ton, 6.3 percent zinc, and 7.7 percent lead from a depth of 207.0 feet. Hole WPC21-09 had 34.5 feet (29.9 feet true-thickness) of massive sphalerite and argentiferous galena averaging 15.24 ounces of silver per ton, 22.5 percent zinc, and 14.5 percent lead from a depth of 358.9 feet.

Western Alaska drilled six shallow NQ drill holes at the Honker prospect, and drilling intersected trace amounts of tennantite, arsenopyrite, and native gold in oxidized ferruginous and scorodite-stained vein silica. Two drill holes targeting a coincident gold-copper-lead-arsenic soil anomaly intersected gossanous material with anomalous gold, silver, and other metals. Six drill holes along the perceived eastern extension of the Illinois Creek syn-mineral fault structure encountered severe sanding of quartzite and dolomitic quartzite but did not intersect the gold-copper enriched Illinois Creek Fault. Two holes drilled at the Last Hurrah CRD prospect did not intersect projected mineralized structures.

In addition to the widely targeted 2021 exploration drilling, a major soil sampling program was completed and was utilized, along with the extensive historical geophysical data sets, to reinterpret the often-confusing stratigraphic relationships in the Illinois Creek property and district as part of the northwestern Alaska mid Jurassic fold-thrust belt. Western Alaska believes that the Illinois Creek district demonstrates an east verging fold-thrust belt comprised of a series of progressively deeper water facies thrust on the more continentally derived rocks to the west. Major manto-form mineralization is modeled to develop at or adjacent to the Illinois Creek Fault and the Waterpump Creek Fault as major syn-mineral structures.

## Hogatza River

Taiga Mining Company, Inc. continued placer gold mining on their claims in the Aloha Creek and Hogatza River areas. Taiga completed geological and geophysical exploration to delineate economically viable placer gold deposits. Exploration work included drilling of at least 330 holes, digging prospect holes, and trenching.

## Eastern Interior

### Fairbanks District

#### Fort Knox

Exploration continued at Kinross Gold Corporation's Fort Knox gold mine 20 miles north of Fairbanks. Exploration drilling focused on the Gil–Sourdough deposit eight miles east of the Fort Knox Mine, along with continued drilling in the western and eastern resource areas of the Fort Knox Mine. Generative exploration also tested early-stage targets northeast of the Fort Knox Mine property. Exploration drilling totaled approximately 18,700 feet.

Resource definition drilling in 2020 and 2021 at the Gil–Sourdough deposit sought to convert and upgrade resources to mineral reserves within the scoping-level pit design and the West North Gil extension zone. An area marked for a planned waste dump was also drilled to determine if any resource estimates could be established. Geologic logging found narrow cross-cutting quartz veins with arsenopyrite and quartz-sericite alteration. Kinross announced plans to begin mining the Gil deposit in 2021.

Kinross also drill-tested prospective mineralization under the Fort Knox pit east ramp, where



shallow-dipping high-grade structures were interpreted. A small exploration program at Fort Knox Phase 9 West was carried out to test the continuity of high-grade structures. Some highlights of this drilling include hole FFC21-1830 with 20 feet grading 0.28 ounces of gold per ton from 1,290 feet to 1,310 feet, and hole FFC21-1835 with 40 feet grading 0.18 ounces of gold per ton from 1,625 feet to 1,665 feet.

#### Amanita

Avidian Gold's Amanita property lies approximately four miles southwest of the Fort Knox Mine. Like the Fort Knox Mine area, the property is underlain by schist and mid-Cretaceous granite, and northeast-trending faults that run through the Fort Knox deposit also transect the Amanita property. A reverse-circulation drilling program planned for 2021 was canceled. Avidian worked with Oriented Targeting Solutions to interpret previously drilled oriented core to properly target known mineralized zones for future drilling.

#### Golden Summit

Freegold Ventures Ltd. resumed exploration drilling at its intrusion-related Golden Summit property approximately five miles north of the Fort Knox Mine near Fairbanks. Freegold defined a bulk-tonnage resource of 2.9 million ounces of gold (app. D) associated with the Dolphin intrusion, and the company completed a preliminary economic assessment (PEA) of the project in 2016.

Following an extensive data review, Freegold identified a potential higher-grade corridor between the Dolphin intrusion and the high-grade veins at the historical Cleary Hill Mine. The initial test of this concept began in February 2020 and continued through 2021. Veins, veinlets, and stockwork zones within areas of intense silicification indicate a robust vein-swarm system. The 2020-2021 drilling results will be incorporated into an updated mineral resource estimate in 2022.

**Photo 7.** Aerial view of Fish Creek, with the Fairbanks Exploration Company Dredge No. 2 in the foreground, and the Gil exploration trenches and trails on the hills to the south. Photo: Brenna Schaake, Kinross Gold Corp.

Freegold drilled 68 holes totaling 124,640 feet in 2021 at the Golden Summit property, with an average hole depth of over 2,000 feet. Key objectives for the 2021 program were to determine the orientation and extent of the higher-grade mineralization between the Dolphin and Cleary zones, expand and upgrade the current resource to further advance the project through pre-feasibility, and to complete additional environmental baseline studies, metallurgical test work, and cultural resource studies. In addition, Freegold planned to test other targets on the project identified by ground geophysics or soil sampling. Results from the 2020–2021 diamond drilling program, including broad zones of above resource grade mineralization, demonstrated the potential for more extensive and higher-grade gold mineralization, now named the Cleary Vein System. The 2021 drilling results were also significantly higher grade than previous resource estimates.

Mineralization at the Golden Summit property occurs in three main forms: (1) intrusion hosted quartz-sulfide stockwork veinlets (such as the Dolphin prospect), (2) auriferous quartz-sulfide veins (historical underground mines), and (3) shear-hosted gold-bearing veinlets. All three mineralization forms are part of a large-scale intrusion-related gold system on the property with the Dolphin intrusion as the apparent source of the mineralization. The drilling program continued to test for a potential higher-grade corridor, effectively a vein swarm, consisting of multiple veins, veinlets and stockwork zones within areas of intense silicification and alteration extending from the area of the old Cleary Hill Mine workings towards the Dolphin intrusion. Drilling also continued to successfully test the potential for higher grade mineralization at the Cleary Hill Mine area well below the level of previous drilling. Significantly, during 2021 intrusive rocks were intersected on the Cleary Hill Mine side at depth, further strengthening Freegold's interpretation that the Dolphin intrusion may underlie the Cleary Hill Mine area at depth, and that the Cleary Hill Mine area may have down dropped along a fault on the east side of Bedrock Creek.

Drilling also continued to target the down-dip extent of the higher-grade vein zones found within the historical Cleary, Colorado, Wackwitz, and Wyoming veins as well as their broader enveloping stockwork zones. Holes drilled in 2021 south of the previous drilling intersected significant veining, quartz breccia, and visible gold in areas with no previous drilling.

Table 9 tabulates some of the significant drill intercepts from the 2021 Golden Summit drill program. Hole GS2165 is one of the best holes drilled in 2021 at the Golden Summit property. Hole GS2165 was collared in the immediate footwall of the Dolphin intrusion and remained predominantly in schist until the end of the hole at 2,287 feet. The hole lies within the Tolovana Vein Zone area, and it is one of the broadest and most consistently mineralized holes at the Golden Summit property to date, averaging 0.036 ounces of gold per ton over 1,836.9 feet, including 279.9 feet grading 0.101 ounces of gold per ton. Freegold also reported the highest-grade intercepts from any drilling on the Golden Summit property, with 17.78 ounces of gold per ton over 3.61 feet in hole GS2121.

Previous drilling across the Golden Summit property was relatively shallow. The 2020–2021 drilling in the area was designed to test if the Cleary Hill Mine mineralization extends to depth. Additionally, drilling was directed to the south of the Cleary Hill Mine workings where previous workings, including the Colorado, Wackwitz, and Wyoming vein zones, have never been tested to depth or along strike. The mineralization at the Cleary Hill Mine not only includes narrow high-grade veins but also includes multiple veins, veinlets, and stockwork zones within broad areas of intense silicification and alteration extending from the old Cleary Hill Mine workings towards the Dolphin intrusion, which has significant implications for both the grade and tonnage potential of the project. More recently, mineralized intrusion has been intersected at depth in the Cleary Hill Mine area, further substantiating Freegold's interpretation that the Dolphin intrusion may underlie the Cleary Hill Mine area.

**Table 9.** 2021 Significant Golden Summit project drilling results.

Zone	Hole Number	From (ft)	To (ft)	Interval (ft)	Grade Au (opt)
Dolphin/Tolovana	GS2101	689.3	1447.2	757.9	0.034
	GS2101	1595.5	1604.0	8.5	0.622
Dolphin/Tolovana	GS2106	187.0	437.0	250	0.035
Dolphin/Tolovana	GS2108	622.0	756.9	134.8	0.117
Cleary	GS2109	1366.5	1388.5	22	0.096
Cleary	GS2112	916.0	949.1	33.1	0.312
Dolphin/Tolovana	GS2115	890.7	897.0	6.2	0.359
Cleary Hill	GS2116	122.7	128.0	5.2	1.247
Dolphin/Tolovana	GS2119	1296.9	1407.2	110.2	0.042
Cleary Hill	GS2121	1010.5	1294.0	283.5	0.057
Dolphin/Tolovana	GS2122	1457.0	1821.9	364.8	0.086
Cleary Hill	GS2123	1203.4	1280.8	77.4	0.081
Dolphin/Tolovana	GS2124	1386.2	1391.1	4.9	0.435
Dolphin/Tolovana	GS2125	1577.1	1687.0	109.9	0.074
Cleary Hill	GS2127	509.5	516.7	7.2	0.887
	GS2127	762.5	772.3	9.8	1.075
Dolphin/Tolovana	GS2128	76.1	196.9	120.7	0.068
	GS2128	1721.1	1726.0	4.9	0.628
Dolphin/Tolovana	GS2129			270.0	0.054
Dolphin/Tolovana	GS2132	1557.1	1966.9	409.8	0.041
Dolphin/Tolovana	GS2133	1295.9	1622.0	326.1	0.042
Dolphin/Tolovana	GS2143	1127.0	1356.6	230.0	0.036
Cleary	GS2144	1566.9	1735.9	169.0	0.060
Dolphin/Tolovana	GS2147	1236.9	1946.9	710.0	0.059
	GS2147	1776.9	1787.1	10.2	0.619
Dolphin/Tolovana	GS2151	187.0	347.1	160.1	0.073
	GS2151	1256.9	2133.9	877.0	0.038
Dolphin/Tolovana	GS2155A	1926.8	1946.9	20.0	0.458
Cleary Hill	GS2156	617.1	624.0	6.9	0.451
Dolphin/Tolovana	GS2158	583.3	677.2	93.8	0.116
Dolphin/Tolovana	GS2159	1327.1	2003.9	676.8	0.033
Dolphin/Tolovana	GS2161	75.8	79.1	3.3	0.850
	GS2161	1682.1	1816.9	134.8	0.045
Dolphin/Tolovana	GS2165	740.2	747.0	6.9	0.437

In addition to its drilling program, Freegold also completed the purchase of 10 patented claims, further solidifying its land position within the project area, and is currently finalizing a mineral lease with the Alaska Mental Health Authority for an additional 1,818 acres immediately north of the project. Cultural resources and water sampling programs were also ongoing.

### **Grant-Ester**

Millrock Resources Inc. sold its Treasure Creek, Ester Dome, and Liberty Bell projects to Felix Gold Ltd. (Australia) for \$210,000, a future share payment, and retained royalties.

Felix Gold has an option to purchase a 100 percent interest in the historical Grant Mine. The Grant Mine is a structurally controlled, auriferous vein-fault deposit hosted in polymetamorphic schist and quartzite. Felix Gold consolidated state claims over Ester Dome and consolidated state and federal claims of the historical Grant Mine. Expenditures in 2021 primarily focused on academic and technical review of the local geology, building a 3-dimensional geologic model, and confirmation of the historical resource at the Grant Mine.

Felix Gold calculated a gold resource for the Grant Mine based on historical data that is compliant with the Australia Joint Ore Reserves Committee (JORC) standards. The Grant Mine contains an Inferred mineral resource estimate of 6.4 million tons, grading 0.057 ounces of gold per ton for 364,000 ounces of contained gold, including an underground resource of 36,000 ounces of gold grading 0.181 ounces of gold per ton. In addition, there is a Grant Mine Exploration Target (JORC, 2012) of 6.2 million tons to 7.3 million tons at a grade of 0.056 ounces of gold per ton to 0.061 ounces of gold per ton for 338,000 to 545,000 ounces of gold, exclusive of the mineral resource.

### **NE Fairbanks**

Felix Gold's NE Fairbanks project consists of consolidated state claims west of Fox, north of the Fort Knox Mine, and south of the Chatanika

River. In 2021, Felix Gold collected 830 reconnaissance soil samples across the area.

### **Treasure Creek**

Felix Gold's Treasure Creek project area consists of consolidated state claims north of Old Murphy Dome Road. In 2021, Felix Gold collected 1,240 soil samples across the area. These samples expanded gold in soil anomalies in the Northwest Array, East Gate, Scrafford Shear, and Wild Cat zones. Two ground geophysical surveys, a gradient array IP, and a pole-dipole line, were completed.

### **Liberty Bell**

Felix Gold acquired the Liberty Bell Mine project in 2021, but no fieldwork was completed. Felix Gold reprocessed historical geophysical and geochemical data for potential future exploration fieldwork.

### **Circle District**

Great American Minerals Exploration, Inc. (GAME) acquired three Kinross Gold Circle District projects (Deep Creek, Mastodon, and Ketchum claims) in December 2020 that are contiguous to their existing claim holdings. The combined holdings of 557 state mining claims cover approximately 60 square miles with historical placer production exceeding 400,000 ounces of gold. GAME planned to reopen some trenches, excavate several new trenches, and do general exploration work. No results were announced.

### **Goodpaster District**

#### **Pogo**

Despite the impacts of COVID-19, Northern Star Resources Ltd. continued exploration activities across the Pogo property centered on the Pogo Mine, 38 miles northeast of Delta Junction. The Pogo deposit includes six underground gold deposits related to an intrusion related gold system. The Liese Vein System consists of at least four stacked flat to moderately dipping quartz veins. The South Pogo, Fun, and Central zones are direct extensions of the Liese veins. The North Zone consists of a series of steep northeasterly dipping sheared quartz veins, while

the East Deep Zone is similar in strike and dip to the Liese Vein System, although it has a higher sulfide content and thinner quartz veins. Gold is most often associated with disseminated sulfides or sulfide veinlets within quartz veins. At the end of 2020, the Pogo deposit had resources of 6.9 million ounces of gold (app. D).

Drilling activity steadily increased after the COVID-19 hiatus, with up to 13 rigs working across the Pogo properties. Underground drilling continued with a focus on resource definition and conversion across most ore systems (Liese, South Pogo, Fun Zone) in the underground mining areas. Drilling intersected multiple high-grade zones, defining additional, previously unmodeled ore. Results at the South Pogo Zone included 9.84 feet grading 2.082 ounces of gold per ton, 24.28 feet grading 0.528 ounces of gold per ton, 37.07 feet grading 0.260 ounces of gold per ton, 12.47 feet grading 0.756 ounces of gold per ton, and 15.09 feet grading 0.610 ounces of gold per ton. Drill results from the Liese 2 Zone included 6.89 feet grading 3.159 ounces of gold per ton, 14.11 feet grading 1.241 ounces of gold per ton, 14.11 feet grading 1.113 ounces of gold per ton, 2.95 feet grading 4.841 ounces of gold per ton, and 11.48 feet grading 1.133 ounces of gold per ton. Definition drilling significantly extended higher-grade gold zones.

Surface exploration drilling activity concentrated on resource definition drilling programs across the central portion of the Goodpaster discovery zone and the Central Gap prospect. At the Goodpaster project, approximately one mile west of the Pogo Mine area, continued excellent drilling results highlighted the “camp-scale” opportunity. Other key regional prospects include Hill 4021, Burn, Cholla, and Stone Boy.

The initial resource definition drilling program at the Goodpaster project was completed during the year with considerable success. Significant 2021 Goodpaster project drill intercepts are listed in table 10. The thickest interval announced was in hole DH21-094, with

22.64 feet of true thickness (drill intercept was 53.15 feet) grading 0.666 ounces of gold per ton.

The Goodpaster mineralized vein system was delineated over a 1.2-mile strike length and remains open in every direction. Drilling confirmed the geological model of shallow to moderate, northwesterly dipping shear zones containing stacked quartz vein structures (G1–G3) combined with several strike-extensive zones of sub-vertical quartz veining (G9). This structural style and characteristic gold–bismuth–telluride mineralization are comparable to the existing northern mining areas, for example, the Fun Zone at the Pogo deposit. A maiden inferred resource for the Goodpaster project is expected in early 2022.

### 64North

The 64North Gold project is a joint venture of Millrock Resources Inc. and Resolution Minerals Ltd. formed to explore claims adjoining Northern Star Resources’ Pogo property.

Resolution Minerals Inc. completed a 3,790-foot rotary air blast drilling program of 27 holes along a 4,600-foot-long fence at the Sunshine prospect. The holes were drilled along the drill trail leading from the Pogo Mine road to the Aurora prospect located to the west of the Pogo Mine. Holes ranged between 150 and 250 foot in depth. The drill holes were designed to test anomalous surface rock samples and a large gold-in-soil anomaly. Drilling results detected gold over a 920-foot-wide corridor, which is



**Photo 8.** Quartz veined granite sample from the 64North Gold project. Photo: Resolution Minerals Inc.

**Table 10.** 2021 Significant Goodpaster project drilling results.

Hole Number	From (ft)	To(Ft)	Interval (ft)	True Thickness (ft)	Au opt
DH21-020				27.9	0.476
DH21-020				7.9	1.326
DH21-021	1310.4	1312.3	1.6	1.6	1.326
DH21-022	666.3	695.2	28.9	22.3	0.537
DH21-024	507.5	543.6	36.4	18.0	0.164
DH21-025	1105.6	1108.6	3.0	2.6	1.302
DH21-027	295.9	298.6	2.6	2.6	0.809
DH21-027	606.0	637.1	31.2	26.9	0.242
DH21-027	1395.0	1397.3	2.3	1.6	1.361
DH21-027	1747.7	1775.3	27.6	21.3	0.201
DH21-033	1309.7	1314.6	4.9	4.3	1.606
DH21-033	1924.9	1928.8	3.6	1.0	2.067
DH21-037	961.0	963.6	2.6	2.3	0.882
DH21-073	1881.9	1890.1	7.9	7.9	0.680
DH21-073	2039.7	2043.6	3.9	3.6	0.566
DH21-078	478.0	480.6	2.6	1.6	5.431
DH21-078	1016.1	1055.4	9.8	8.2	0.254
DH21-078	1561.0	1569.9	8.9	2.3	1.142
DH21-079	712.6	741.1	28.9	7.5	1.965
DH21-079	786.1	807.1	21.0	14.8	0.207
DH21-082	1771.7	1774.0	2.0	2.0	1.308
DH21-083	1798.6	1799.9	1.3	1.3	1.513
DH21-084	1036.1	1039.4	3.3	3.3	3.361
DH21-084	1968.8	1976.7	7.9	5.6	0.496
DH21-084	2161.4	2165.4	3.9	3.3	6.249
DH21-085	760.8	767.7	6.9	4.9	0.423
DH21-085	784.8	815.0	30.2	21.3	0.304
DH21-085	851.4	870.1	18.7	10.8	0.336
DH21-085	1342.8	1356.0	13.1	12.1	0.447
DH21-086	1151.6	1161.1	9.5	9.5	0.283
DH21-087	1647.3	1649.9	2.6	2.3	1.653
DH21-094	1565.3	1618.4	53.1	22.6	0.666
DH21-095	1816.3	1818.2	1.6	1.6	3.460
DH21-098	1897.6	1899.3	1.6	1.6	2.964

open at depth and to the north and south. The host granite intrusion is interpreted to extend more than three thousand feet to the south of the drilling. Of the 27 holes drilled, nine holes intersected gold mineralization grading above a cut-off grade of 0.003 ounces of gold per ton, including hole 21SU009 with 245 feet grading 0.008 ounces of gold per ton. There is a strong association of bismuth and arsenic with gold.

Resolution also completed drilling on the East Pogo prospect. A reverse circulation (RC) drill was used to test shallow, gently dipping conductive zones identified by ZTEM and CSAMT geophysical surveys. A total of 5,454 feet was drilled over 12 holes. Gently dipping altered, graphitic zones with quartz and sulfides were reported in several holes, with quartz veins up to 15-feet thick. Assay results indicate only anomalous gold with strongly elevated geochemical pathfinder elements associated with minor quartz veining and sericite and biotite alteration.

Two trenches, totaling 2,690 feet, were completed at the Tourmaline Ridge prospect to test soil geochemistry and geophysical results. Multiple gold-bearing quartz veins were intersected, with the best result of 0.140 ounces of gold per ton over 3.28 feet. Resolution interprets the results to represent south-dipping, antithetic hanging wall veins, directly above a major dilation northwest dipping shear zone.

Resolution also conducted regional programs to investigate the porphyry potential of the Elaine prospect and gold potential of the Kramer and Last Chance prospects.

### **Tibbs**

Tectonic Metals, Inc. continued exploration at their Tibbs gold project 22 miles east of the Pogo Mine. Mineralization at the Tibbs project comprises high-grade, near-surface gold hosted by both high- and low-angle quartz–pyrite–arsenopyrite–stibnite veins and sheeted-to-stockwork quartz–sulfide veins.

In 2021, Tectonic Metals Inc. completed 16 line-miles of TITAN-160 ground-based IP

geophysical surveys, geochemical sampling, prospecting, geological mapping, trenching, and drilling. Tectonic conducted orientated core diamond drilling and RC drilling across the Tibbs property. Intrusion-related gold targets were drilled at the Michigan and Wolverine prospects and orogenic style gold targets were drilled at the Gray Lead, Gray Lead West, Galosh, Johnson Saddle, West Trench, and Carrie Creek/Tibbs South prospects. Tectonic Metals Inc. completed 16,463 feet of drilling at its Tibbs gold project during 2021. This drill program included 8,855 feet of RC drilling in 18 holes and 7,608 feet of oriented core diamond drilling testing in 12 holes.

The Michigan prospect is a broad, north-east-trending structural corridor within granodiorite which has been traced for 900 feet along strike and to a depth of 820 feet. The best intercept from three oriented core holes totaling 1,810.5 feet drilled at the Michigan prospect during 2021 came in hole TBDD21-001, which cut 20 feet of quartz–stibnite–pyrite–arsenopyrite veining with visible gold hosted by strongly sericitized granodiorite averaging 0.225 ounces of gold per ton.

Core drilling at the Gray Lead prospect, a vertical quartz vein target, intersected quartz vein hosted gold mineralization in three of four holes drilled in 2021. Drilling included 22.6 feet grading 0.166 ounces of gold per ton in hole TBDD21-006 and 16.9 feet grading 0.364 ounces of gold per ton in hole TBDD21-007.

A total of 3,147 feet of drilling in four holes was completed at the Gray Lead West prospect, a previously untested target about 1,000 feet west of the Gray Lead prospect. Core hole TBDD21-012 intersected four intervals of low-angle, ~20- to 30-degree west-dipping quartz veins, including 2.46 feet grading 0.291 ounces of gold per ton and 1.97 feet grading 0.223 ounces of gold per ton, with associated arsenic–bismuth–tungsten–tellurium geochemistry. Three RC holes drilled at this prospect also intersected quartz vein-hosted gold mineralization that Tectonic correlates along trend with a vein in hole TBDD21-012, defining nearly 2,300 feet of potential strike between holes.



At the Galosh prospect, two reconnaissance RC drill holes spaced 2,000 feet apart were drilled into a large soil anomaly, coinciding with high and low-angle structures observed in TITAN geophysics, centered along a gneissic ridgeline 1.5 miles north of the Gray Lead prospect. Quartz vein-hosted mineralization was intersected in hole TBRC21-007, including 10 feet averaging 0.071 ounces of gold per ton from a depth of 540 feet, in an interval of strong silica-sericite alteration.

A gold–arsenic soil anomaly in gneissic rocks at the Johnson Saddle prospect, coincident with arcuate low-angle structures observed in TITAN geophysics, was targeted with one core and one RC drill hole. The drill holes intersected multiple shear zones and thin quartz veins. The best drill intercept graded 0.100 ounces of gold per ton over 5 feet.

Drilling at the West Trench prospect totaled 3,123 feet in a combination of two diamond drill holes (TBDD21-009, TBDD21-010) and three RC holes (TBRC21-004 to 006) targeting prominent high-angle structures within a previously untested gold–arsenic–bismuth–antimony soil anomaly coincident with low- and high-angle structures identified in a Titan geophysical survey and a quartz vein rock sample containing 5.60 ounces of gold per ton. Drilling confirmed the presence of controlling high-angle fault structures adjacent to low-angle fractures and structurally controlled alteration zones. Drill results included weak gold mineralization associated with structures and quartz–arsenopyrite–pyrite veins with visible gold specks.

At the Wolverine prospect, hole TBDD21-008 drill tested a fault structure with coincident gold-in-soil and electromagnetic anomalies along a prominent air photo linear feature. The core hole drilled through altered granodiorite and diorite consisting of fault gouge and rubble for the entirety of the hole, with mineralization peaking at 0.019 ounces of gold per ton over 6.56 feet.

### **Carrie Creek/Tibbs South**

In 2021, Tectonic Metals Inc., completed field mapping, prospecting, surface sampling, and RC drilling of the Carrie Creek property leased

from Doyon Ltd. Surface rock sampling yielded gold values from trace up to 1.47 ounces of gold per ton and 904 parts per million bismuth, with quartz-gold-bismuthinite veins in granodiorite talus blocks. The Jorts prospect and the Jeans prospect, about a mile apart in the southwestern part of the property, are the most promising prospects and appear to represent a continuation of the Brink deposit and the Porthos Ridge exploration target immediately west of the Jeans prospect. Subsequent follow-up RC drilling totaling 3,900 feet was completed in nine holes. Five RC holes were completed at the Jorts target, with granodiorite-hosted gold mineralization associated with weak to moderate chlorite alteration and elevated bismuth, tungsten, and tellurium values intersected in four holes. The best intercept was 5 feet grading 0.052 ounces of gold per ton in hole CCRC21-008.

### **Maple Leaf**

In 2021, Tectonic Metals Inc. carried out geochemical sampling, prospecting, and geological mapping on the Maple Leaf gold project adjacent to the Tibbs property.

### **Mt. Harper**

The Mt. Harper property is comprised of 49,800 acres of underexplored land about 15 miles east of the Tibbs property and was historically explored for tungsten and possible base metal mineralization. Tectonic Metals Inc. has identified at least three styles of mineralization, including copper-tungsten-silver skarn, stockwork gold-molybdenum quartz veining, and quartz vein breccia-hosted gold-silver-bismuth. Granodiorite is prevalent across the property and Tectonic interprets mineralization at the Section 21 prospect to likely represent a porphyry-type system.

In 2021, Tectonic completed a field program at the Mt. Harper property consisting of geological mapping and prospecting over priority target areas. A total of twenty-one days were spent with a four-person crew prospecting and mapping, resulting in the collection of one-hundred-and-twenty-five rock samples. No geochemical results were announced.

## Healy Claims

Kenorlands Minerals Ltd., formerly Northway Resources Corp., in joint venture with Newmont Corp., completed a 14-hole, 17,215-foot drill program at its Healy gold property, located 29 miles southeast of the Pogo Mine. Mineralization styles at the Healy property include disseminated sulfide, quartz-carbonate vein-hosted sulfide, and breccia-fill sulfide including arsenopyrite, pyrite, and stibnite with rare sphalerite. Pervasive alteration is dominantly sericite, carbonate with lesser fuchsite associated with structural features. Geochemical associations of gold with silver, antimony and arsenic are interpreted to indicate an overall distal intrusion-related setting for the Healy gold system.

The 2021 core drill program tested large coherent gold–arsenic–antimony soil geochemical anomalies within a package of dominantly metamorphic rocks including schist, paragneiss and augen gneiss at the Bronk, Thor, and Spike prospects. All drill holes intersected broad low-level gold mineralization with associated widespread disseminated sulfides, alteration, and veining. Examples include 120.7 feet within a steeply dipping shear zone grading 0.010 ounces of gold per ton in hole 21HDD011 at the Bronk prospect and 43.9 feet within the hanging wall of a low-angle structure grading 0.036 ounces of gold per ton in hole 21HDD019 at the Thor prospect.

In addition to the core drill program, a high-powered induced polarization (Titan IP) survey and magneto-telluric (MT) survey was completed across a 3-mile-long line transecting the Thor, Bronk, and Spike target areas. The IP and MT surveys, which imaged up to 2,600-foot and 2.5-mile depth respectively, support the interpretation of shallowly dipping, east-verging architecture with mineralization occurring along low angle thrust faults and steeper cross-cutting fault corridors. Broad zones of disseminated sulfide and strong alteration are well-defined in the chargeability and resistivity data, with zones of combined high chargeability and low resistivity (high conductivity) correlating well with mineralized intercepts from the 2021 drill program.

## Richardson Subdistrict SAM

GAME, in a joint venture with Koza Ltd. (USA) Inc. (operator and majority interest), conducted a 153-hole, 34,744-foot resource upgrade and exploration core and RC drill program at its consolidated SAM gold project in the Richardson mining subdistrict between Fairbanks and Delta Junction. Drilling included 58 RC and 10 core holes at the Naosi deposit, 71 RC holes at the Mon East prospect, seven core holes at the Lone Tree prospect, and four core holes at the Hope Creek area. The program focused on upgrading the gold resources at the Naosi deposit and testing other targets across its consolidated Monte Cristo–Uncle Sam property. GAME also constructed road access to the property and completed initial metallurgical studies at the Naosi deposit. The Naosi deposit hosts a 2021 updated, indicated resource of 997,000 ounces of gold at an average grade of 0.054 ounces of gold per ton and an inferred mineral resource of 575,000 ounces of gold at an average grade of 0.034 ounce of gold per ton; of this total, an estimated 1,075,000 ounces are in oxidized rock, with the balance in refractory sulfide-bearing rock (app. D). The resource also includes 22 million ounces of silver. A PEA for the Naosi deposit is in progress.

## Shamrock

The Shamrock property in the Richardson Mining District near Salcha was staked by Contango ORE Inc. in March 2021. The property includes a total of 368 state mining claims covering approximately 52,920 acres. Contango intends to explore for three gold deposit types on the Shamrock property: 1) Pogo-style gold mineralization in the low angle quartz veins; 2) Fort Knox-style intrusion-related gold deposits (IRG) associated with igneous intrusions where they intersect deep seated crustal structures; and 3) high level rhyolite intrusive dikes with associated clay and silica alteration which occurs in the Democrat and Banner dikes areas of the property. Contango field crews collected 835 soil samples using a power auger and 75 surface rock chip samples at the Banner Creek and Hilltop prospects of the Shamrock property.

## Tolovana District

### Livengood

International Tower Hill Mines Ltd.'s (ITH) Livengood gold project is an advanced-exploration-stage, intrusion-related gold deposit located 75 road miles northwest of Fairbanks. The Money Knob deposit at Livengood hosts a gold resource estimated at 13.62 million ounces consisting of 776.6 million tons of measured and indicated resources averaging 0.018 ounces of gold per ton. Proven and probable mineral reserves total 474.1 million tons at an average grade of 0.019 ounces of gold per ton (9.0 million ounces, app. D).

ITH prepared an updated PFS for the Livengood project in 2021. This new economic and engineering study, which supersedes a PFS completed in 2017, integrates new interpretations based on an expanded geological database, improved geological modeling, new resource estimation methodology, an optimized mine plan, and extensive metallurgical work carried out over the past four years. Estimated capital costs of the project are \$1.93 billion, and it generates an after-tax net present value (5 percent discount rate) of \$45 million and an internal rate of return of 5.3 percent. Under this scenario, the operation would pay back the \$1.93 billion of initial capital expenditures in 10.2 years.

The evaluated project configuration is a conventional, owner-operated surface mine that would utilize large-scale mining equipment in a blast/load/haul operation. Mill feed would be processed in a 65,000-tons-per-day comminution circuit consisting of primary and secondary crushing, wet grinding in a single semiautogenous (SAG) mill, and single ball mill followed by a gravity gold circuit and a conventional carbon in leach circuit. The mine plan developed would support an annual production rate of approximately 317,000 ounces per year over an estimated 20.3-year mine life, producing a total of approximately 6.4 million ounces of gold.

The 2021 Livengood work program also advanced the baseline environmental data

collection in critical areas of hydrology and waste rock geochemical characterization as needed to support future permitting, as well as advanced community engagement.

### Shorty Creek

South32 Ltd. continued its joint venture agreement to explore Freegold Ventures Ltd.'s Shorty Creek prospect, an intrusion-related, copper–gold–silver–tungsten property approximately 75 road-miles northwest of Fairbanks. The 2021 program was fully funded under the Shorty Creek Option Agreement.

Eight widely spaced core holes, totaling 11,151 feet, were drilled on the property and provided a limited test of the areas outside of the Hill 1835 area, where Freegold previously focused its attention. The drilling program tested magnetic anomalies and IP chargeability high anomalies. Drillhole SC2103 was designed to test an IP chargeability high and coincident magnetic low. The hole intersected 314 feet of 0.12 percent copper, 0.001 ounces of gold per ton, and 0.047 ounces of silver per ton starting at 484.9-foot depth. The remaining seven holes had no significant intervals of mineralization.

### McCord Gold

Endurance Gold Corporation acquired and maintained claims in the McCord Creek area near Livengood since 2010. No exploration work was conducted during 2021.

### Elephant Mountain

Endurance Gold Corp. acquired a 100 percent interest in the Elephant property, located in the Hot Springs Mining District, by completing all the obligations to earn its interest, including incurred exploration expenditures of \$200,000, issued to the vendor 400,000 common shares of the company with a value of \$24,125 and paid cumulative cash payments totaling \$200,000. Minor exploration work was completed in 2021.

Endurance also continued its option on the nearby Trout and Wolverine properties. No work was conducted during 2021.

### Manh Choh Project (formerly Peak Gold)

Kinross Gold Corp. and Contango ORE Inc. continued the 70/30 Peak Gold JV work on the Manh Choh gold–silver project (formerly known as the Peak Gold project), located on Tetlin Native lands 11 miles south of Tok. The joint venture intends to develop the project by trucking the ore 250 miles to the Fort Knox mill in Fairbanks. This scenario avoids the capital costs and extended timelines associated with the design, construction, and permitting of on-site processing and tailings storage facilities. A feasibility study is expected in 2022, followed by construction in late 2022, and full-scale production in 2024. The mine is anticipated to produce approximately one million ounces of gold over a four-and-a-half-year mine life.

The skarn deposit hosts measured, indicated, and inferred resources of 0.927 million ounces of gold at an average grade of 0.115 ounce of gold per ton and 3.4 million ounces of silver at an average grade of 0.423 ounce of silver per ton (app. D).

Contango retained Sims Resources LLC to prepare a technical report summary on the Manh Choh project. The project contains two deposits, the Main Peak and North Peak. Main Peak is a largely unoxidized distal amphibole–chlorite skarn with gold, silver, and copper mineralization associated with pyrrhotite, chalcopyrite, and arsenopyrite hosted in recumbent folded calcareous schist and marble interbedded with amphibolite grade argillaceous schist and quartzite. The highest gold grades occur in dark green amphibole-rich skarn with coarse grained arsenopyrite and coarse-grained pyrrhotite, with total sulfide percentages ranging from 5 to 15 percent. North Peak is a largely oxidized distal skarn with mineralization dominated by hematite, limonite, goethite, copper oxides, and scorodite-rich clays hosted in recumbent folded calcareous schist and marble interbedded with amphibolite grade argillaceous schist and quartzite. According to a new resource estimate calculated under U.S. S-K 1300 standards for Contango, the Manh Choh deposits host 10.14

million tons of measured and indicated resources averaging 0.119 ounces of gold per ton, equal to 1.21 million ounces of gold, and averaging 0.415 ounces of silver per ton, equal to 4.2 million ounces of silver. Inferred resources total 116,000 ounces of gold and 694,000 ounces of silver, with 1.48 million tons averaging 0.079 ounces of gold per ton and 0.470 ounces of silver per ton.

Kinross had a \$19 million exploration budget for the Manh Choh project. The 2021 program at Manh Choh focused on in-fill drilling to upgrade resources, as well as water monitoring wells for environmental baseline. Drilling to support further metallurgical test work and pit geotechnical studies, along with ongoing environmental baseline and community outreach work is also being carried out this year. At Manh Choh, favorable geology and pathfinder geochemistry was documented at the East, Ridgeline, South, Seven O'clock and Two O'clock targets.

The Peak Gold JV spent approximately \$15.8 million on the 2021 drilling program and completed 33,010 feet of core drilling on the Manh Choh project in 2021. The drilling was mostly directed towards in-fill drilling to support a detailed mine plan and feasibility study, with additional drilling to support on-going geotechnical, metallurgical, environmental studies and water quality data collection. Significant drill intercepts are listed in table 11, including 33.1 feet grading 2.087 ounces of gold per ton in hole TET21468.

In addition, the Peak Gold JV submitted a permitting package to the USACE for the wetlands dredge and fill permit, also known as a 404 permit, just prior to the end of the 2021. The Peak Gold JV approved a 2022 program for a feasibility study, permitting, on-going environmental monitoring, community engagement, engineering, early construction, and exploration. The initial construction at the Manh Choh project is scheduled to start during the summer 2022. The Peak Gold JV plans to release a feasibility study in 2022 which will outline the anticipated tons and grades of ore delivered to the Fort Knox mill for processing and expected ounces of

**Table 11.** 2021 Significant Manh Choh project drilling results.

Hole Number	From (ft)	To (Ft)	Interval (ft)	Gold Grade (oz/ton)
TET21468	113.5	146.7	33.1	2.087
TET21483	83.0	108.3	25.3	1.064
TET21488	549.5	647.0	97.4	0.142
TET21489	350.1	393.7	43.6	0.837
TET21493	0.0	54.5	54.5	0.849
TET21495	126.6	185.4	58.7	0.370
TET21496	103.0	117.8	14.8	1.451
TET21497	0.0	51.5	51.5	0.495
TET21505	442.9	487.9	44.9	1.105

gold and silver to be recovered over the reserve life of the mine.

The Peak Gold JV was a substantial contributor to the local Tok economy, with over \$1.7 million spent in the area during 2021. Alaska-based businesses received 74 percent of the local spending. The JV also made \$208,000 in donations to local nonprofits and community organizations.

### Eagle-Hona

Contango Ore Inc. explored the Eagle-Hona claims northwest of the Manh Choh property. A surface sampling program collected 2,084 rock chip samples, including 97 trench samples, and 62 pan concentrate samples. This program follows a 2013 stream sediment sampling reconnaissance program that identified an over six mile long northwestern-trending corridor in which every creek draining the northeast slopes of the mountains showed strongly anomalous gold, arsenic, and copper.

### Seventymile

Tectonic Metals, Inc. did not conduct field exploration in 2021 at its Seventymile shear-zone-hosted gold project, located 40 miles west of Eagle. The project includes the Flanders, Alder Creek, and Bonanza Creek lode prospects, among others, and is leased from underlying



**Photo 9.** Traversing along rubble and outcrop exposures on Contango ORE Inc.'s Eagle property. Photo: Luke Raymond.

landowner Doyon, Ltd. Geophysical data reprocessing, including 2D structure detection and 3D magnetic inversion, was completed.

### Tanacross

Kenorland Minerals Ltd.'s Tanacross project comprises a cluster of porphyry-type prospects about 55 miles northeast of Tok, including the Taurus, Bluff, East Dennison, Pushbush, and Big Creek prospects. In 2021, Kenorlands Minerals Ltd. completed detailed mapping, soil sampling, and geophysics. Detailed soil sampling and rock chip mapping was carried out over the East Taurus, West Taurus, and South Taurus target areas, covering an area of approximately 10 square miles. An additional detailed soil sampling and mapping

grid was completed over the Big Creek target area within the southern portion of the property. In total 2,340 soil samples were collected over the Taurus and Big Creek areas. High-resolution drone magnetic surveys, totaling 388 line-miles, were carried out by Pioneer Exploration of Ottawa, Ontario, Canada, over the same areas covering the East, West and South Taurus areas, as well as the Big Creek area. In addition, a high-powered IP survey and a MT survey was completed by Quantec Geoscience along a three-mile survey line over the South Taurus target area. A seven-mile road was also constructed.

### Golden Zone

Avidian Gold Alaska Inc.'s Golden Zone property, 25 miles southwest of Cantwell and accessed off the Parks Highway, contains numerous igneous-related mineral occurrences over a 9.3-mile strike length. The property's Golden Zone Breccia Pipe deposit has an NI 43-101-compliant resource of 6.1 million tons grading 0.05 ounce of gold per ton and 0.247 ounce of silver per ton, totaling 303,300 ounces of gold and 1,509,200 ounces of silver (app. D).

Avidian completed a RC drilling program in 2021 with contractor Midnight Sun Drilling. Twenty-seven holes, totaling 10,787 feet, were drilled in the Mayflower Extension Zone (MEZ), Copper King, and Long Creek areas. Avidian collected 2,275 samples for assay.

The primary objective of the seventeen-hole 2021 MEZ drill program was to define mineralization that lies to the northeast of the Breccia Pipe deposit and is believed to have the highest potential to add additional gold ounces proximal to the Breccia Pipe deposit. Five holes drilled in the northeastern most portion of the MEZ encountered visible sulfides and alteration of replacement style mineralization in the conglomeratic unit. These holes extend the mineralized zone to the northeast by an additional 650 feet from previous drilling. Near the southwestern most portion of the MEZ, three holes were drilled that also encountered visible sulfides and alteration similar to the central MEZ, thereby extending the mineralized

zone 300 feet to the southwest and giving the zone a total strike length of approximately 2,000 feet adjacent to the Breccia Pipe deposit. The drill holes to date at MEZ have vertical depths of less than 500 feet, leaving the deposit open at depth and along strike to the northeast.

One of the best intercepts from the drilling at the northeast portion of the MEZ was in hole GZ21RC-02 with a 50-foot intersection grading 0.059 ounces of gold per ton. A highlight from drilling at the southwestern portion of the MEZ was in hole GZ21RC-22 with a 50-foot intersection grading 0.077 ounces of gold per ton.

A total of 4,962 feet of drilling in ten RC holes was completed on the Copper King and Long Creek prospects located approximately 2.5 miles to the south of the Breccia Pipe deposit. Five holes targeted replacement style mineralization in the conglomeratic unit along 2,600 feet of strike length. Varying amounts of pyrite, arsenopyrite, and chalcopyrite were noted in four holes. The other five holes were drilled to test a prospective quartz-eye porphyry granite and a CSAMT Impedance anomaly, with all holes intersecting mineralization.

The best intercept from the three holes drilled at the Long Creek prospect was in Hole GZ21RC-07 with 5 feet grading 0.065 ounces of gold per ton, 0.534 ounces of silver per ton, and 0.43 percent copper hosted in the conglomerate. Drill hole GZ21RC-13, at the Copper King prospect, had the best intercept of the seven-hole program, with two mineralized zones, including 5 feet grading 0.049 ounces of gold per ton.

Avidian geologists also completed detailed field mapping, prospecting, and geochemical sampling at the Southwest Prospects area. Mineralized gossan was discovered and sampled. Pioneer Exploration Consultants Ltd. flew 745 line-miles of a drone-based, airborne magnetometer survey covering 18.9 square miles.

### Chulitna

Discovery Alaska Ltd., formerly Discovery Africa Ltd., staked 308 state mining claims

covering historical gold–silver–copper and tin–silver prospects. The roughly 77-square-mile land package, now known as Chulitna, covers the Partin Creek and Coal Creek prospects about four miles west of the Parks Highway near the Golden Zone property. Fieldwork primarily focused on confirming and expanding upon known gold occurrences at three primary areas of the Partin Creek prospect: North Zone, South Zone, and West Vein. The completed fieldwork program was conducted with helicopter support over a two-week period and included the collection of 253 samples (167 rock and 86 talus fines) and geological mapping. The highest geochemical results from the rock sampling included 2.158 ounces of gold per ton, 43.8 ounces of silver per ton, and 2.62 percent copper.

### Alaska Range Projects

PolarX Ltd.'s Alaska Range projects include the Caribou Dome property and the Stellar property covering several copper- and gold-bearing deposits and prospects accessed from the Denali Highway between Paxson and Cantwell. These include the sediment-hosted-copper Caribou Dome deposit, with nine lenses of volcanic sediment-hosted massive sulfide (pyrite and chalcopyrite) mineralization (3.1 million tons grading 3.1 percent copper; app. D); the Zackly gold–copper skarn deposit (3.75 million tons grading 1.2 percent copper, 0.058 ounce of gold per ton, and 0.409 ounce of silver per ton; app. D); and the Saturn, Jupiter, Mars, and Gemini porphyry copper–gold–molybdenum targets.

PolarX's 2021 program focused on the Caribou Dome and the Zackly deposits. Eight core holes were drilled at the Caribou Dome deposit, with four in-fill holes and four exploration holes. The four infill holes, CD21-001 to CD21-004, drilled known high-grade massive sulfide lenses to provide fresh samples for metallurgical testing. The best hole was CD21-001 with three intercepts averaging greater than 6.8 percent copper, including a 62.6-foot-thick intercept (41.3-foot true thickness) averaging 7.0 percent copper and 0.327 ounces of silver per ton.

Exploration holes were drilled to test two of three coincident geochemical and IP geophysical anomalies. The exploration holes encountered disseminated, vesicle infillings, and vein-hosted native copper in volcanic rocks in three of the holes drilled roughly 3,800 feet apart. Assays for these four holes confirm the presence of native copper but grades are not significant enough to justify further exploration for this style of mineralization.

The assay and metallurgical results from the 2021 program will provide data for a scoping-level study that investigates the potential of processing ore from Caribou Dome and Zackly at a central processing facility on the Alaska Range properties. Metallurgical test work evaluated the gravity separation of coarse free-milling gold and the flotation of copper sulfides from gravity circuit residues for co-processing Zackly Main, Zackly East, and Caribou Dome ores. The scoping study is expected to be completed in early 2022.

### Red Mountain

White Rock Minerals Ltd. continued early-stage exploration for both gold and massive sulfides at its Red Mountain project in the northern Alaska Range in 2021. The property hosts an array of zinc–lead–copper–silver–gold-bearing VMS deposits and prospects, with the best known being the Dry Creek deposit (2.6 million tons; app. D) and the West Tundra Flats deposit (7.4 million tons; app. D). The property also contains the Last Chance prospect, a newly defined gold target with gold–arsenic–antimony-bearing quartz-cemented breccias and veins.

A total of 14,124.5 feet of core drilling in 12 holes was completed during 2021 at the Red Mountain project. Four holes were completed on the resource area at DC North testing the down dip potential of the Fosters and Discovery massive sulfide deposits. Seven holes were also completed testing new VMS targets in the district, including the Hunter West, Kiwi, and Jack Frost prospects, and one hole was drilled on the Last Chance gold system.

Three of four drill holes at Dry Creek extended sulfide mineralization 650 feet down dip along a 3,000-foot stretch of the deposit. Drill hole DC21-97 intersected 19 feet of massive and laminated sulfide averaging 11.5 percent zinc, 3.4 percent lead, 2.01 ounces of silver per ton, 0.023 ounces of gold per ton, and 0.1 percent copper.

Surface exploration focused on continued ground examinations of selected conductors identified from the 2019 airborne SkyTEM regional survey, with subsequent CSAMT and fixed-loop EM ground surveys, and more than 7,500 soil samples and 275 rock samples. White Rock discovered five new VMS prospects found along a 20-mile-long Keevy VMS trend and staked an additional 58 mining claims covering 15 square miles. The Kiwi prospect contains massive sulfide float, with assay results of up to 16 percent copper, 8 percent zinc, and 9.23 ounces of silver per ton. The Jack Frost prospect contains massive sulfide float assay results of up to 14 percent zinc, 20 percent lead, and 8.32 ounces of silver per ton. Drill hole HR21-07 at the Hunter West prospect intersected an eight-inch-thick massive sulfide lens at a 606-foot depth, grading 11.9 percent zinc, 2.8 percent lead, 0.9 percent copper, and 1.84 ounces of silver per ton.

Exploration of gold-arsenic-antimony targets continued at the Last Chance prospect. However, a planned drill program was canceled due to the lack of available drills and crews.

### **Valdez Creek Lode**

The Valdez Creek gold lodes lie in the headwaters of the Valdez Creek placer deposits in the south-central Alaska Range. Historical exploration identified five vertically stacked, gold-bearing zones over a vertical distance of 600 feet with a strike length of over 900 feet. The claims are currently being explored by Valdez Creek Mining LLC, but no exploration was announced for 2021.

### **Delta VMS Project**

The Delta mineral belt, approximately 35 miles west of Tok, hosts VMS mineralization with

inferred resources totaling 18.8 million tons at average grades of 4.5 percent zinc, 0.6 percent copper, 1.9 percent lead, 1.96 ounces of silver per ton, and 0.048 ounce of gold per ton (app. D).

Agnico analyzed historical geophysical surveys to reinterpret and produce new models to define drilling targets. Other activities included acquisition and analysis of TITAN DCIP data, drill hole planning for 2022, prospecting and geologic evaluation of historical prospect areas. Agnico Eagle Mines Ltd. and Kirkland Lake Gold Ltd. announced plans in late 2021 to merge into a major mining company.

### **Napoleon**

The Napoleon project is an early-stage, high-grade lode gold prospect in the Fortymile Mining District near Chicken. The prospect was drilled in the late 1990s and early 2000s. Kenorland Minerals Ltd. sold the Napoleon project to J2 Metals Inc., a private mineral exploration company, in early 2021. J2 Metals completed a month long, 13 RAB drill hole program on the Napoleon project testing step-out targets from known mineralization along geophysical identified structures. Assay results from the 2021 drilling program included 0.063 ounces of gold per ton over 10 feet in hole 21NAPRAB-001 and 0.086 ounces of gold per ton over 10 feet in hole 21NAPRAB-007. J2 Metals retained Apex Geoscience Ltd to complete a Canadian NI 43-101 report on the Napoleon project summarizing past work on the project and providing a justification for expenditures going forward.

### **Nikolai/Eureka Zone**

Millrock Resources Inc. assembled an extensive land package in the Delta River Mining District. The Nikolai project hosts nickel-copper-chromium-cobalt-platinum group element prospects. In total, Millrock's Nikolai project consists of 146 State of Alaska mining claims covering 36.5 square miles in a highly prospective, underexplored, mineralized ultramafic belt.

At the Eureka claim block, 104 State of Alaska mining claims were staked by Millrock.



Prospects form a northwest trend of soil and rock anomalies that contain elevated nickel, copper, platinum, palladium, and gold. Mineralization, sampled on surface and by drilling, is associated with serpentinized mafic and ultramafic rocks.

At the Canwell claim block, Millrock entered into an option agreement to purchase 42 State of Alaska mining claims from David Johnson. Historical surface rock sampling and drilling characterized nickel–copper–platinum group element mineralization associated with mafic and ultramafic dikes/sills. The dikes/sills are hypothesized as deep-rooted feeders to the same ultramafic sills located at the Eureka claims.

Millrock conducted a one-day field visit to collect due diligence samples at various prospects to validate historical assay values reported by previous explorers. Drillholes for Eureka and Canwell were reviewed for geology and mineralization at the GMC in Anchorage. Historical core, drilled by bcMetals, was located, relogged, and assayed for platinum group elements and gold to add to the existing database. Millrock consolidated historical information and built a Leapfrog 3D model based on historical information.

## South-Central Region

### Johnson Tract

The Johnson Tract (JT) gold and base-metal deposit lies 125 miles southwest of Anchorage. The property was discovered by Anaconda in 1982 and is being explored by HighGold Mining Inc. under a lease agreement with Cook Inlet Region, Inc. (CIRI). Geologically, it comprises gold–silver–zinc–copper–lead mineralization associated with quartz stockworks and is hosted in Jurassic volcanoclastic rocks; mineralization is interpreted to have formed in a sub-seafloor setting contemporaneous with the host stratigraphy, comparable to a VMS deposit. There are at least nine other altered and (or) mineralized prospect areas over a 7.5-mile strike length.

In early 2020, HighGold announced an initial indicated mineral resource of 2.4 million tons at an average grade of 0.18 ounce of gold per

ton, 0.17 ounce of silver per ton, 5.85 percent zinc, 0.57 percent copper, and 0.8 percent lead, for a total 417,000 ounces of gold, or 750,000 ounces “gold-equivalent” when including the other metals (app. D). An updated mineral resource, including the results from the 88,600 feet of drilling since the maiden resource was completed, is expected in the second quarter of 2022.

The 2021 program consisted of a 53,143-foot, 45-hole drill program, with 26 holes (32,536 feet) at the JT deposit area, 17 holes (17,343 feet) at the Difficult Creek (DC) prospect and 2 holes (3,264 feet) at the Kona prospect. The program also included property-wide geological mapping and geochemical sampling, as well as prospect-scale airborne and ground-based geophysical surveying.

Highlights from JT deposit area drilling included hole JT21-125, a metallurgical hole from the deeper, higher-grade portion of the JT deposit, with 185.7 feet grading 0.546 ounces



**Photo 10.** HighGold geologist examines drill core at the JT deposit with Mt. Iliamna in the background. Photo: HighGold Mining Inc.

of gold per ton, 2.4 percent zinc, 0.36 percent lead, and 0.47 percent copper, with subintervals including 16.4 feet grading 1.889 ounces of gold per ton, 1.5 percent zinc, and 0.53 percent copper, and 16.1 feet grading 3.341 ounces of gold per ton, 3.5 percent zinc, and 0.33 percent copper. Hole JT21-134, an infill hole from the upper parts of the deposit, was also noteworthy and intersected 277.9 feet starting at 217.5-foot depth, averaging 0.137 ounces of gold per ton, 4.6 percent zinc, 1.6 percent lead and 0.3 percent copper, with a subinterval of 111.6 feet averaging 0.216 ounces of gold per ton, 7.0 percent zinc, 3.6 percent lead and 0.4 percent copper. Mineralization in both holes was in silicified, veined, and brecciated dacite tuff.

Results to date successfully expand the JT deposit to over 2,000 feet of strike length and confirm continuity of higher-grade gold mineralization, with mineralization open along strike to the northeast and southwest, and at depth. The true thickness of the JT deposit typically ranges from 66 to 164 feet.

Drilling along strike and the down-plunge extents of the JT deposit and related Footwall Copper Zone intersected multiple discrete zones of mineralization. For example, drill hole JT21-123 intersected some of the highest silver grades (7.067 ounces of silver per ton) to date at the JT deposit and is developed within a mudstone host stratigraphically overlying strongly anhydrite-altered dacite lapilli tuff. These features are often found in gold-rich VMS deposits. Thirteen holes drilled around the periphery of the JT deposit intersected narrow zones of zinc-rich, silver-gold mineralization, and defined a shallow, broad halo to the JT deposit mineralizing system that extends over a strike length of 2,790 feet and over a width up to 295 feet.

HighGold also conducted a regional drilling program and outlined multiple priority target areas for future drilling related to the 3.5 mile long regional Milkbone Fault system. One of the highlights of the regional program was a bonanza-grade gold intercept from drilling at the

Middle DC target, about 2.5 miles north of the JT deposit. Mineralization consists of an anastomosing network of narrow quartz-sulfide veins within a variably silicified zone of quartz-sericite-pyrite alteration developed within dacitic to rhyolitic tuffaceous and fragmental volcanic rocks, similar to the JT deposit host rocks. Hole DC21-010 intersected 21 feet averaging 18.58 ounces of gold per ton, 65 ounces of silver per ton, 2.15 percent zinc, and 0.3 percent copper. This intercept ranked as the third best drill intercept in the world during 2021 according to Opaxe, an independent Australian mining database company that compiles the best drill intersections reported around the globe and then ranks them based on gold-equivalent grams per metric ton.

The other drillholes from the Middle DC, Upper DC, and Central Fault zones at the DC prospect intersected narrow high-grade gold and silver intervals, as well as broad intervals of lower grade gold associated with significant base metal mineralization. HighGold plans additional drilling in this area in 2022.

Surface exploration indicates that the Middle DC area may be part of an almost one-mile-long prospective corridor. Rock and soil sampling at the Milkbone prospect, which lies about 3,300 feet southwest of the Middle DC prospect, include geochemical results from grab samples of quartz vein breccia and quartz-sulfide vein containing up to 0.418 ounces of gold per ton, 17.49 ounces of silver per ton, 18.6 percent lead, 10.1 percent zinc, and 5.0 percent copper.

The Milkbone fault is also associated with gold mineralization at the Easy Creek prospect, about 3.7 miles north of DC. Easy Creek is defined by a one-mile-by-1.25-mile strong induced polarization geophysical anomaly that is coincident with anomalous soil geochemistry, rock samples with up to 0.847 ounces of gold per ton, large-scale hydrothermal alteration, and a circular magnetic anomaly associated with an intrusive plug. Located somewhat lower stratigraphically than the JT deposit and DC discovery, Easy Creek

may represent a portion of the deeper roots of the large-scale Johnson Tract mineralized system.

The Kona prospect lies about 1.5 miles west of Middle DC and bears a similar geophysical signature to the Easy Creek prospect. Two drill holes targeting IP chargeability and resistivity anomalies associated with a mapped alteration zone at the Kona prospect did not intersect any significant mineralization.

A metallurgical program was undertaken by Blue Coast Metallurgy & Research in 2021 using core sample material collected from the JT deposit, with results anticipated in the second quarter of 2022. The program includes QEMSCAN mineralogical studies; identification of potential geometallurgical domains; grindability, gravity, and flotation test work; and the development of a metals recovery flowsheet.

## **Willow Creek District**

### **Lucky Shot**

Contango Ore Inc. purchased the Lucky Shot property on the north side of Hatcher Pass from CRH Funding II PTE. Ltd. The Lucky Shot property includes 725 acres of patented mining claims and 7,865 acres of State of Alaska mining claims which cover three former producing gold mines in the Willow Creek Mining District. The Coleman, Lucky Shot and War Baby mines are located along a continuous low-angle structural zone occupied by a series of high-grade quartz veins hosting free gold and minor sulfide and telluride mineralization. Total gold production from the Willow Creek district through 1950 is approximately 610,874 troy ounces, making it the third largest historical lode gold producing district in Alaska. Production from the Lucky Shot was reported to be 252,000 ounces of gold from 169,000 tons of free-milling ore, with additional production from the Coleman and War Baby mines. A 2016 prefeasibility study estimated measured and indicated resources containing 121,500 ounces of gold (app. D).

Contango plans to re-establish underground access to drill the down-dip extension

of the Lucky Shot and Coleman veins, infilling and expanding previously identified mineralization. In 2021, Alaska Gold Torrent, LLC, a wholly owned subsidiary of Contango, carried out mapping, modeling, geologic interpretation, and mine development planning. A snow shed was built at the entrance to the Enserch Tunnel allowing year-round safe access. Contango staked approximately 8,000 acres of state mining claims immediately north and east of the Lucky Shot property covering several historically (pre-World War II) active mines. Efforts continued through the winter to improve existing mine access.

### **Icy Cape**

Icy Cape is a gold- and heavy mineral beach-placer prospect located in the Gulf of Alaska near Icy Bay, about 75 miles northwest of Yakutat. The land is owned by the Alaska Mental Health Trust Authority and managed by the Trust Land Office (TLO). The TLO's Icy Cape Gold and Industrial Heavy Minerals project is a staged, incremental effort to evaluate the potential for producing industrial heavy minerals (garnet, epidote-group minerals, magnetite, ilmenite, zircon, and rutile) as part of a placer gold operation. In the summer of 2021, a high resolution airborne gradient magnetic survey was flown over the project area. The results of this survey will assist in resource definition drilling scheduled to begin in early summer 2022.

### **Genesis (Tonsina)**

New Age Metals Inc. worked on the Genesis platinum-group-element-copper-nickel project. The project is located near Glenallen and consists of chromite-associated platinum and palladium mineralization and stratabound nickel-copper-platinum-group-element mineralization within steeply dipping magmatic layers of the Sheep Hill portion of the Tonsina Ultramafic Complex. Past sampling returned results up to 0.070 ounces of palladium per ton, 0.070 ounces of platinum per ton, 0.96 percent nickel, and 0.58 percent copper. Aurora Geosciences Ltd., completed a surface rock, soil and stream sediment geochemical sampling and geological mapping program at the Bernard Mountain and Sheep Hill areas. Rock grab samples

were collected, and small soil sample pits were dug to assess soil profiles at target areas outlined from previous work. No results were announced.

### Chisna

Millrock Resources Inc. owns a 100 percent interest in several claim blocks covering the Chisna porphyry copper-gold project. Millrock collected geochemical data over interesting geophysical anomalies identified in a proprietary ZTEM – MAG geophysical survey.

## Southwestern Region

### Donlin Gold

The Donlin Gold project, a proposed large open-pit gold mine, is being explored by Donlin Gold LLC, a 50/50 partnership between Barrick Gold Corp. and NovaGold Resources Inc., on lands owned by Calista Corporation and The Kuskokwim Corporation. The intrusion-related deposit contains proven and probable reserves of 34 million ounces of gold at an average grade of 0.06 ounce of gold per ton (app. D) and is one of the world's largest undeveloped gold deposits.

In 2021, Donlin Gold conducted its second consecutive large drill program, with 79 holes drilled totaling 79,606 feet, compared to 85 holes drilled totaling 76,772 feet during 2020 in the ACMA and Lewis deposit areas. The drill program objective was to validate recent geologic- and resource-modeling concepts and to test potential extensions of high-grade zones in preparation for updating a feasibility model. Drilling focused on further testing of orebody continuity and structural control, and data collection for geotechnical and geometallurgical analysis. Results from the ACMA and Lewis deposit areas continued to exceed modeled grade-thickness. A new area, named Divide, on the eastern side of the ACMA pit area and transitioning into the Lewis pit area, provided significant high-grade drill hole intercepts. Mineralized structures in the Divide area are interpreted as potential feeder zones of the Donlin Creek gold system.

One of the best holes drilled in 2021 was hole DC21-1970, with a 301.9-foot intersection

starting at 228.67-foot drilled depth grading 0.228 ounces of gold per ton, including sub-intervals of 17 feet grading 0.984 ounces of gold per ton and 10.5 feet grading 0.853 ounces of gold per ton. Other significant drilling results are listed in table 12.

Donlin Gold employed a local workforce from 20 Yukon-Kuskokwim communities for the 2021 season and approximately 70 percent of Donlin Gold direct hires for the drill program were Alaska Natives. Donlin Gold continued to enforce strict COVID-19 protocols with established contingency plans in place to keep employees, their families, and members of the community safe and healthy. Employees and contractors were subject to mandatory COVID-19 testing prior to traveling to camp as well as upon arrival. Out of roughly 171,310 hours worked during 2021, only four cases of COVID-19 were recorded at the Donlin Gold project site.

Donlin Gold's Clean Water Act (CWA) Section 401 certification of the CWA Section 404 permit was appealed in Alaska Superior Court by an Environmental Non-Governmental Organization (ENGO) representing Orutsararmiut Native Council in June 2021. The Alaska Department of Environmental Conservation (ADEC) had previously upheld a certification of reasonable assurance that the proposed mine would comply with the state's water quality standards.

Twelve water rights permits were finalized and issued by the DMLW on June 29, 2021. In July, the water rights permit issuance was administratively appealed by an ENGO representing five tribal groups in the Yukon-Kuskokwim region. A decision on the appeal is anticipated in 2022.

In April 2020, the DNR's Division of Oil and Gas agreed to reconsider its decision on the ROW for a proposed 316-mile-long buried natural gas pipeline originating at Cook Inlet. On July 19, 2021, the DNR commissioner completed the reconsideration and upheld the ROW. In September, two appeals of the ROW were filed in

**Table 12.** 2021 Significant Donlin Gold project drilling results.

Zone	Hole Number	From (ft)	To (ft)	Interval (ft)	Grade Au (opt)	
Divide	DC21-1959	1242.9	1323.1	80.2	0.428	
	including	1269.0	1290.3	21.3	0.979	
Lewis	DC21-1961	904.0	922.8	18.8	1.233	
	including	904.0	919.6	15.6	1.482	
Lewis	DC21-1962	524.0	633.5	109.5	0.152	
ACMA	DC21- 1963A	375.0	509.4	134.4	0.308	
	including	384.6	433.7	49.1	0.649	
Divide	DC21-1964	363.0	487.2	124.2	0.183	
	including	363.0	389.1	26.1	0.467	
	including	470.4	480.6	10.3	0.298	
ACMA	DC21-1969	838.5	999.7	161.1	0.142	
		1072.3	1161.4	89.1	0.233	
	including	1314.0	1470.8	156.8	0.263	
	including	1317.0	1336.6	19.6	0.528	
	including	1359.6	1398.9	39.3	0.404	
ACMA	DC21-1970	1452.2	1470.8	18.6	0.329	
		228.7	530.6	301.9	0.226	
	including	232.0	242.5	10.5	0.851	
	including	268.7	278.6	9.9	0.409	
	including	344.0	346.1	12.0	0.365	
	including	479.1	496.1	17.0	0.985	
		568.2	631.0	62.8	0.367	
		587.9	627.8	39.9	0.505	
Lewis	DC21-1972	466.1	481.9	15.8	0.514	
Lewis	DC21-1973	201.8	213.7	12.0	0.551	
		330.0	344.2	14.2	0.605	
ACMA	DC21-1976	887.0	1074.8	187.8	0.201	
		including	948.0	961.3	13.3	0.529
ACMA	DC21-1978	789.0	821.2	32.2	0.366	
Divide	DC21-1979	330.4	406.3	75.9	0.223	
		including	350.1	365.3	15.2	0.585
Lewis	DC21-1980	962.6	1002.6	40.0	0.555	
		including	985.2	1000.5	15.3	1.067
ACMA	DC21-1986	1044.1	1126.6	82.5	0.148	
		52.5	149.3	96.8	0.118	
ACMA	DC21-1994	0.0	110.0	110.0	0.172	
		including	30.3	50.2	19.9	0.444
		861.4	1115.9	254.5	0.102	
	including	1059.5	1085.5	26.0	0.362	
Lewis	DC21-1998	339.7	490.1	150.4	0.089	
Divide	DC21-2007	509.7	557.8	48.1	0.172	
Lewis	DC21-2010	908.8	918.6	9.8	0.537	
ACMA	DC21-2015	89.1	230.2	141.1	0.147	
		including	95.9	115.5	19.7	0.345
Lewis	DC21-2017	474.2	536.5	62.3	0.532	
Lewis	DC21-2019	512.7	605.3	92.6	0.128	

Alaska Superior Court, one by an ENGO representing several tribal groups and one by an outdoor recreational business owner in the pipeline area.

The Alaska Department of Fish and Game (ADF&G) issued two Special Area Permits required for pipeline facilities in November. In December, ADEC approved a third extension of the project's air quality permit.

In September 2021, the ANCSA Regional Association Board of Directors unanimously passed a resolution in support of the Donlin Gold project. The resolution acknowledged that, under provisions of ANCSA Section 7(i) and 7(j), financial distributions from the Donlin Gold project will benefit the shareholders and families of the twelve ANCSA regional corporations and more than 200 village corporations throughout the State of Alaska.

Donlin Gold, together with its partners Calista Corporation and the Kuskokwim Corporation, carried out a wide range of community engagement and support initiatives during the year. In August, Donlin Gold partnered with the Delta Backhaul Company, the Association of Village Council Presidents, and other regional groups on the fourth "In it for the Long Haul" backhaul project to collect, remove, and safely dispose of approximately 180,000 pounds of household hazardous and electronic waste from 26 Yukon-Kuskokwim area villages.

## Pebble

The Pebble porphyry copper–gold–molybdenum deposit is one of the world's largest undeveloped mineral resources. The project is being advanced by the Pebble Limited Partnership (PLP), a wholly owned subsidiary of Northern Dynasty Minerals, Ltd. From 2001, when Northern Dynasty's involvement at the Pebble project began, to December 31, 2021, a total of \$893 million has been invested to advance the project.

The Pebble deposit comprises two zones, the surface-minable Pebble West, and the larger and higher-grade Pebble East, which would require underground block-cave mining. Combined,

the deposit has a total mineral resource (all categories) of 82.0 billion pounds of copper, 106.5 million ounces of gold, 5.6 billion pounds of molybdenum, 515 million ounces of silver, and 4,630 tons of rhenium (app. D). Elevated levels of palladium, vanadium, titanium, and tellurium were noted in raw analytical data and in metallurgical studies and represent opportunities to further benefit the economics of the Pebble deposit.

PLP focused on facilitating and providing support to the federal EIS permitting process and subsequent appeal from 2017 to early 2022. The PLP also continued to actively engage and consult with project stakeholders to share information and gather feedback on the Pebble project, its potential effects and proposed mitigation.

On November 25, 2020, the USACE denied PLP's CWA Section 404 permit, stating that the Compensatory Mitigation Plan (CMP) was not adequate to compensate for the expected impacts of the project, and that the project was not in the public interest. The PLP submitted its request for appeal of the ROD to USACE on January 19, 2021. The request for appeal reflected the PLP's position that USACE's ROD and permitting decision, including its "significant degradation" finding, its "public interest review" findings, and its rejection of the PLP's CMP, are contrary to law, unprecedented in Alaska, and fundamentally unsupported by the administrative record, including the proposed project final EIS.

In a letter dated February 24, 2021, USACE confirmed the PLP's request for appeal was complete and met the criteria for appeal. In August 2021, the USACE informed the PLP that a new Review Officer had been appointed to lead the Pebble project appeal. The appeal process continued into 2022.

On January 22, 2021, the State of Alaska, acting in its role as owner of the lands and subsurface estate containing the Pebble deposit, also submitted a request for appeal of the ROD. The state appeal was rejected on the basis that the state did not have standing to pursue an administrative appeal with the USACE.

On September 9, 2021, the EPA announced plans to re-initiate the process of making a CWA Section 404(c) determination for the waters of Bristol Bay, which would set aside the 2019 withdrawal of that action that was based on a 2017 settlement agreement between the EPA and the PLP. After court proceedings, the EPA subsequently extended the deadline to either withdraw the proposed determination or to prepare a recommended determination regarding the Pebble project until May 31, 2022.

Fieldwork in 2021 focused on continuation of select environmental baseline studies, site maintenance, and closure of unrequired monitoring wells. Work included support and data collection for the USGS stream gauge monitoring program on the South and North Fork Koktuli rivers, and support for site visits.

In 2021, PLP also advanced engineering, metallurgical and other technical studies, and released the 2021 Pebble project PEA report. The PEA presented the projected economics of the production plan and a corresponding project configuration which aligns with the June 2020 revised project application. Seven potential project expansion scenarios were also identified for consideration in the PEA. Three of those scenarios outline a potential mine life of more than 100 years. Other scenarios consider the addition of an onsite gold plant.

The PEA projects that the total initial capital cost for the design, construction, installation, and commissioning of the proposed project is estimated to be \$6.05 billion, which includes all direct, indirect, and other costs. The proposed project would provide 20 years of open pit mining with a processing rate of 180,000 tons per day, an internal rate of return of 15.7 percent and net present value at 7 percent discount rate of \$2.3 billion. Average annual metal production was projected to be 320 million pounds of copper, 368,000 ounces of gold, 15 million pounds of molybdenum, 1.8 million ounces of silver and 26,450 pounds of rhenium.

Life-of-mine metal production was calculated as 6.4 billion pounds of copper, 7.4 million ounces of gold, 300 million pounds of molybdenum, 37 million ounces of silver, and 0.5 million pounds of rhenium. The average annual net smelter return would be \$1.6 billion, with a life-of-mine net smelter return of \$32 billion.

The Pebble project could potentially provide more than \$8 billion to the Southwest Alaska region through the Pebble Performance Dividend and the Lake and Peninsula Borough severance tax over the life of the potential expansion scenarios. This monetary benefit is in addition to the benefits that could flow from the existing and possible future agreements with Alaska Native Village Corporations.

### **Groundhog**

The Groundhog prospect, explored by Quaterra Resources Inc. and Chuchuna Minerals Company, is a copper–gold porphyry exploration project lying 190 miles southwest of Anchorage and 14 miles north of the Pebble deposit. Limited fieldwork was conducted in 2021. Quaterra Resources Inc. changed its corporate name to Lion Copper and Gold Corp.

### **Terra**

WestMountain Gold Inc. paused exploration at its structurally controlled, high-grade Terra gold vein system in the western Alaska Range. The project hosts an estimated 420,000 ounces of gold at an average grade of 0.446 ounces of gold per ton (app. D). All permits and reclamation plans for continued exploration were renewed in 2021. Samples were collected outside of the current resource areas to test possible new mineralized zones.

WestMountain Gold completed a property evaluation program including water quality sampling, wetlands analysis, scoping study and mine plan, camp facilities maintenance, road maintenance, as well as extended and improved 1,000 feet of runway. WestMountain Gold also drilled 100 feet of core samples and collected surface samples for geochemical analysis.

## Alaska Range Estelle

Nova Minerals Ltd. continued its aggressive exploration of the Estelle gold project in the western Alaska Range, approximately 110 miles northwest of Anchorage. The Estelle project covers a 125-square-mile property with a 22-mile-long corridor. Nova Minerals added to the land package in 2021 by staking 368 state mining claims. There are 21 identified gold prospects and the project's Korbel Main-area deposit is a near-surface, reduced-intrusion-related gold system with gold–bismuth–tellurium-bearing quartz–arsenopyrite–chalcopyrite–pyrrhotite veins and associated quartz–sericite–pyrite alteration.

Nova Minerals continued exploration at the Estelle project in 2021. Core drilling was conducted with up to five drill rigs, at the Korbel and RPM prospects. RC drilling was conducted at Blocks C and D, Isabella, and Connex across the flat ground of the Korbel Valley. Drilling continued throughout the year with higher-grade feeder zones discovered at the Korbel Main deposit and a bonanza gold grade reported at the RPM North deposit.

Nova Minerals reported extensive drilling results from their campaign at Korbel. These long intercepts generally averaged less than 0.015 ounces of gold per ton, and included shorter intercepts, generally 10-foot thick, up to 0.350 ounces of gold per ton. The highest-grade long intercept from the 2021 drilling at the Korbel area was in drillhole KBDH-072, with a 1,010-foot intercept from surface averaging 0.020 ounces of gold per ton.

Drill results from the RPM North prospect, about 16 miles south of the Korbel Main prospect, included some thick, higher-grade intervals. The best drillhole, RPM-005, averaged 0.111 ounces of gold per ton for 1,224 feet starting at a depth of 23 feet, including a 433-foot-thick intercept averaging 0.295 ounces of gold per ton and a 7.9-foot-thick intercept that averaged 1.469 ounces of gold per ton.

Nova Minerals released a maiden JORC-compliant inferred resource at its RPM North deposit. The RPM North deposit hosts 25.35 million tons of inferred resource averaging 0.058 ounces of gold per ton, totaling 1.5 million ounces of gold. Nova Minerals also upgraded the JORC-compliant resource at the Korbel Main deposit by 74 percent to 8.1 million ounces, including 315.26 million tons of indicated resource averaging 0.009 ounces of gold per ton (3 million ounces of gold) and 642.65 million tons of inferred resource averaging 0.009 ounces of gold per ton (5.1 million ounces of gold). The Estelle project has a total mineral resource of 9.6 million ounces of gold (app. D).

Nova Minerals also started exploring some of the other 19 identified prospects within the Estelle Trend. An exploration mapping and sampling campaign at the Train and Shoeshine prospects discovered another large gold system exposed at surface with a 0.6-mile-long and 0.3-mile-wide strike at the Train prospect, and 0.6-mile-long strike length at the Shoeshine prospect. High-grade reconnaissance rock samples yielded analytical results up to 0.888 ounces of gold per ton.

An exploration mapping and sampling campaign at the Stoney prospect confirmed a massive polymetallic mineralized vein observed along 2.5 miles of strike length, up to 33 feet wide, and greater than 1,000 feet of vertical extent. High grade reconnaissance rock chip samples had analytical results up to 1.413 ounces of gold per ton, 79.424 ounces of silver per ton, and 2.4 percent copper.

In July, due to increased external sample processing times, Nova Minerals set up its own on-site sample preparation lab capable of processing up to 7,500 samples per month. The on-site lab was expected to reduce costs and improve assay turnaround times.

In November, SnowCat Services of Alaska built a 100-mile-long snow road to connect Estelle to the towns of Willow and Wasilla for up to four months of the year. Nova Minerals planned



to expand their Whiskey Bravo man camp near Korbelt and install safety huts at RPM.

Nova Minerals also continued work on its scoping study and completed phase one of the preliminary economic study. Work commenced on phase two of the preliminary economic study to be completed in late 2022. Jade North, LLC was contracted to advance an environmental work program and provide permitting guidance.

Scanning electron microscopy work conducted during metallurgical studies indicate that the gold at Estelle is almost entirely associated with arsenopyrite. As part of the phase 2 metallurgical work, ore sorting test-work programs conducted by TOMRA in Sydney demonstrated the potential of ore sorting using X-ray transmission (XRT) technology to successfully separate the gold bearing veins at the Korbelt Main deposit. Ore sorting results showed up to a 10-fold upgrade from a 0.65-ton rock sample. The processing of the reject material by XRT technology for further cost savings is also being investigated.

### Monte Cristo

Ragusa Minerals Ltd., an Australian company, entered the Alaska exploration market with a deal to acquire the 125-square-mile Monte Cristo property near Estelle and Whistler North. Ragusa entered into a binding Heads of Agreements with Iridium Resources PTY Ltd to acquire 100 percent of Stradun Australia Pty Ltd., which owns 100 percent of the Monte Cristo project.

The Monte Cristo property consists of 500 state mining claims and covers a 35-mile-long under-explored area. The project area contains four historical prospects: Monte Cristo, St. Eugen, Old Man Breccia, and Old Man Diorite. These gold prospects will be priority exploration targets to conduct initial exploration work.

### Whistler

The Whistler project is a gold-rich porphyry copper project consisting of 304 state mining claims covering roughly 42,000 acres in the Alaska Range. It is located approximately 105 miles northwest of Anchorage and 81 miles west

of Willow. Current year-round access to the property is via aircraft flying into the Whiskery Bravo airstrip shared with Nova Minerals Ltd.'s Estelle project. More than \$36 million has been spent exploring for gold-copper porphyry and intrusion-related gold deposits on the Whistler property since initial exploration by Cominco Alaska Inc. in 1986. A total of 230,469 feet of diamond drilling in 257 holes were drilled on the Whistler property from 1986 to 2011, with 69,331 feet in 52 holes drilled in the Whistler deposit area, 67,188 feet in 94 holes drilled in the Raintree area, 47,277 feet in 36 holes drilled in the Island Mountain resource area, and 46,673 feet in 75 holes drilled in areas outside the three resource areas. No significant exploration work was conducted on the project after 2016.

GoldMining Inc. announced an updated mineral resource estimate for the Whistler, Raintree West, and Island Mountain deposits in June 2021 (app. D). The Whistler, Raintree West, and Island Mountain deposits host 130.3 million tons of indicated resource averaging 0.015 ounces of gold per ton (1.94 million ounces), 0.064 ounces of silver per ton (8.3 million ounces), and 0.16 percent copper (422 million pounds). The deposits also have an additional inferred resource of 349 million tons averaging 0.013 ounces of gold per ton (4.67 million ounces), 0.046 ounces of silver per ton (16.1 million ounces), and 0.10 percent copper (711.4 million pounds). The Whistler deposit is estimated to contain an indicated resource of 1.75 million ounces of gold, 399 million pounds of copper, and 6.76 million ounces of silver, with an inferred resource of 1.71 million ounces of gold, 455 million pounds of copper, and 7.31 million ounces of silver. The Raintree West deposit has an open-pit indicated resource of 0.12 million ounces of gold, 15 million pounds of copper, and 1.22 million ounces of silver, with an inferred open-pit resource of 0.29 million ounces of gold, 18 million pounds of copper, and 1.73 million ounces of silver. The Raintree West deposit also has an underground indicated resource of 0.07 million ounces of gold, 8 million pounds of copper, and 0.36 million ounces of silver, with

an inferred underground resource of 1.03 million ounces of gold, 107 million pounds of copper, and 3.21 million ounces of silver. The Island Mountain deposit has an inferred open-pit resource of 1.70 million ounces of gold, 131 million pounds of copper, and 3.81 million ounces of silver.

### Nyac

The Nyac area, approximately 60 miles northeast of Bethel, includes an active placer mining operation and several lode gold prospects. Landowner Calista Corp. continued to explore for lode sources of the extensive known placer gold resources in 2021. Shareholders from the local community were rehired and further trained for prospecting in addition to soil sampling. Exploration work consisted of prospecting, geological mapping, and rock and soil sampling. In addition, a targeted core relogging program further evaluated copper porphyry potential. New mineralization occurrences were identified and known occurrences were extended. The exploration project operated safely and successfully under Calista's COVID-19 mitigation policy adapted for the field with zero COVID-19 cases.

### Shotgun

The Shotgun project is an intrusion-related gold system in the southern Kuskokwim region. Shotgun has an inferred resource of 706,000 ounces of gold (app. D). TNR Gold Corp. consolidated and updated the mining claims at the Shotgun project during 2021.

### Flat

Tectonic Metals Inc. entered into an agreement with Doyon Limited for the Flat gold project. Under the terms of the lease, Tectonic paid Doyon \$30,000 upon signing the agreement and is required to make \$40,000 payments to the ANCSA corporation in years two through five, \$50,000 annual payments in years six through nine, and \$100,000 annually for the balance of the initial 15-year lease. Doyon also retains a two percent net smelter royalty for precious minerals and a one percent net smelter royalty for base minerals until the fifth anniversary of

commencement of commercial production. Tectonic committed to an annual \$10,000 scholarship payment to the Doyon Foundation or another accredited institution as directed by Doyon for the term of the lease. To keep the lease on the Flat property in good standing, Tectonic must complete \$1 million of exploration by the end of 2023, including \$500,000 in 2022. Tectonic carried out a due diligence reconnaissance trip to the newly acquired property in 2021.

The Flat project consists of two main target areas: Chicken Mountain and Black Creek/Golden Horn. The Chicken Mountain target is an open ended, greater than 100 parts per billion gold-in-soil anomaly extending 2.36 miles by 2,000 feet in a north-northwest orientation over the core of the exposed Chicken Mountain quartz monzonite stock. Gold is hosted within quartz veins containing free gold, arsenopyrite, pyrite, stibnite, cinnabar, and rare chalcopyrite. Previous drilling intersected bulk tonnage gold mineralization, including thinner, high-grade intervals.

Mineralization at the Black Creek/Golden Horn target is contained within north-east-striking, steeply-dipping, sheeted subparallel veins. Narrow veins contain quartz and limonite, while wider veins (up to 18 inches thick) contain open space fillings of massive stibnite with pyrite, arsenopyrite, cinnabar, scheelite, and native gold. Vein and disseminated bulk tonnage mineralization is hosted within sedimentary and volcanic rocks. Most notable is the Golden Hornfels (Golden Horn) zone which occurs along the eastern contact of the Black Creek stock.

Tectonic plans to conduct data compilation prior to a preliminary metallurgical test work program utilizing existing drill core. Fieldwork is planned for 2022.

### West Susitna Access Road

On October 27, 2021, the AIDEA announced that it received \$8.5 million in funds for the advancement of pre-development work for the West Susitna Access Road project, which would extend into resource-rich areas west of

Cook Inlet. Originally proposed under Alaska's Roads to Resources program, the West Susitna Access Road would run about 100 miles northwest from the Port MacKenzie area, opening the west side of Cook Inlet to responsible natural resource development.

The AIDEA planned to carry out the third and final phase of a feasibility analysis for initial pre-development work. The scope of work included the competitive procurement of a third-party contractor to assist the AIDEA with the USACE application process and initiating an environmental impact analysis through the NEPA. The AIDEA anticipates having a third-party under contract in late December 2021 to assist in this process.

Access to this region west of Cook Inlet is expected to provide many new opportunities for Alaskans, with easier access to six million acres of recreation area. In addition, the state's economy is expected to enjoy growth from the resource development opportunities offered by providing less expensive access to the gold, silver, copper, strategic metals, oil and gas, agricultural lands, timber resources, and alternative energy options in this region.

## Luna

Riversgold Ltd. agreed to divest its Alaska portfolio (Luna, Quicksilver, and Kisa properties) to Mamba Minerals LLC. Riversgold will receive \$1.5 million in cash, with a retained 1.5 percent gross revenue royalty on all minerals produced. The agreement included additional payments if inferred mineral resources exceed certain thresholds. Mamba had already paid \$290,000 under the terms of the earn-in and joint venture deed. Mamba made a \$60,000 payment at execution of the deed on April 12.

## Southeastern Region Greens Creek

Hecla Mining Company continued surface and underground exploration on the Greens Creek Mine property southwest of Juneau. Successful exploration by Hecla continued to

ensure reserves at least 10 years ahead of current mining at this silver–gold–zinc–lead VMS deposit. See appendix D for detailed reserves and resources for the Greens Creek deposit.

Underground definition and exploration drilling during 2021 at the Greens Creek Mine were conducted on eight of the nine known mineralized zones on the property. Drilling replaced reserves in 2021.

Two underground core rigs focused on definition drilling at the East Ore, Upper Plate, Northwest West, 9A, and 200 South zones while exploration drilling began testing the southern extensions to the 200 South and Gallagher zones. Highlights from the East Ore Zone drilling include intercepts containing 28.5 ounces of silver per ton, 0.33 ounces of gold per ton, 10.5 percent zinc and 3.7 percent lead over 19.9 feet and 8.9 ounces of silver per ton, 0.18 ounces of gold per ton, 11.1 percent zinc and 2.9 percent lead over 34.5 feet, both located at the hinge zone between the sub-vertical and sub-horizontal portions of the East Zone. Highlights from the Upper Plate Zone include intercepts containing 34.4 ounces of silver per ton, 0.12 ounces of gold per ton, 9.5 percent zinc and 4.4 percent lead over 23.1 feet and 37.9 ounces of silver per ton, 0.13 ounces of gold per ton, 6.2 percent zinc and 3.1 percent lead over 25.8 feet. Other drilling in the Upper Plate Zone targeted the southern portion of the zone along 100 feet of strike length and expanded known mineralization to the west and to the south. Highlights from this drilling include intercepts containing 28.29 ounces of silver per ton, 0.01 ounces of gold per ton, 4.69 percent zinc and 2.77 percent lead over 8.1 feet occurring within a zone of multiple tight folds.

Drilling at the Northwest West zone focused on the northern portion of the zone along 150 feet of strike length and expands mineralization to the north. Highlights from this drilling include 24.99 ounces of silver per ton, 0.10 ounces of gold per ton, 3.89 percent zinc and 1.76 percent lead over 11.5 feet at the targeted horizon. Highlights from the 9A drilling include 24.50 ounces of silver per

ton, 0.17 ounces of gold per ton, 14.34 percent zinc and 9.32 percent lead over 21.0 feet, 30.37 ounces of silver per ton, 0.27 ounces of gold per ton, 8.22 percent zinc and 4.01 percent lead over 19.8 feet, 29.2 ounces of silver per ton, 0.39 ounces of gold per ton, 19.0 percent zinc, and 10.6 percent lead over 8.0 feet and 19.2 ounces of silver per ton, 0.14 ounces of gold per ton, 10.5 percent zinc, and 6.4 percent lead over 14.0 feet.. Other drilling in the 9A Zone targeted the southern portion of the zone along 150 feet of strike length and includes intercepts containing 20.10 ounces of silver per ton, 0.08 ounces of gold per ton, 9.83 percent zinc and 6.09 percent lead over 24.3 feet and 40.81 ounces of silver per ton, 0.14 ounces of gold per ton, 3.96 percent zinc and 1.51 percent lead over 6.0 feet, both at the targeted horizon.

Drilling in the 200 South Zone targeted expanding and upgrading resources in the central and southern portions of the zone. Highlights include intercepts containing 60.0 ounces of silver per ton, 0.02 ounces of gold per ton, 8.6 percent zinc and 4.1 percent lead over 4.6 feet and 25.7 ounces of silver per ton, 0.23 ounces of gold per ton, 2.0 percent zinc, and 1.0 percent lead over 6.0 feet.

Two surface core rigs also began drill testing the Lil'Sore trend target located three miles north-northwest of the mine and a southerly extension of the mine's 5250 Zone. The second drillhole into the Lil'Sore target intersected four zones of mineralized footwall rocks consistent with VMS feeder zone 'stringer' style of mineralization. These intercepts include mineralized sericite phyllite grading 0.6 ounces of silver per ton, 12.2 percent zinc, and 0.8 percent copper over 6.6 feet true width and massive fine-grained base metal sulfide and mineralized chloritic rock containing 1.7 ounces of silver per ton, 4.4 percent zinc, and 6.6 percent copper over 3.3 feet true width. These copper and zinc-rich intercepts are hosted in footwall rocks showing a fertile feeder stockwork zone. The entire stratigraphic package has been overturned after mineralization, so these results indicate potential for a mineralized mine contact at depth or laterally.

## Kensington

The Kensington Mine lies 43 miles northwest of Juneau and is owned and operated by Coeur Alaska Inc. The mine celebrated its first decade of gold production in 2020, and its current reserves and resources (1.6 million ounces of gold total) represent the next decade of production (app. D). Coeur spent \$11 million on exploration during 2021, drilling step-out targets with two surface-based drill rigs, while three underground core drill rigs focused on resource expansion and conversion in the new Elmira vein development.

The 2021 Kensington exploration program started with two underground core rigs focused on infill drilling along the Elmira and Jualin vein structures. By mid-year, three underground and two surface core rigs were drilling infill and expansion targets across the property. Underground exploration drilling targeted the Elmira, Johnson, Kensington Main, upper Kensington Zone 30, Jennifer, Eureka and Raven veins. The two surface core rigs drilled the upper portions of the Jualin, Big Lake, Gold King and Valentine-Tremming vein systems. Roughly 156,500 feet were drilled during 2021, including 86,800 feet of expansion drilling and 69,700 feet of infill drilling.

The Elmira Vein and the development drift established in late 2020 represent potential areas of future mining at the Kensington Mine. Significant drill intersections of the Elmira Vein varied from 0.5 feet to 22.7 feet, with grades from 0.14 to 6.43 ounces of gold per ton. Hole EL21-0850-192-X30 was notable, intersecting 14.6 feet grading 1.06 ounces of gold per ton. Hole EL21-0850-156-X11 returned 10.4 feet of 0.81 ounces of gold per ton, 0.8 feet of 6.43 ounces of gold per ton and 1.4 feet of 1.54 ounces of gold per ton.

Expansion drilling at the Johnson Vein, about 500 feet east of the Elmira Vein, continued to better define the vein shape. Drill hole JN21-0900-181-X02 intersected 1.2 feet of vein grading 1.31 ounces of gold per ton. Drill hole EL21-0850-156-X22 intersected 9.9 feet of vein grading 0.75 ounces of gold per ton and 8.4 feet grading 0.18 ounces of gold per ton.

New infill holes into the upper Kensington Zone 30 structure encountered excellent grade thicknesses, as demonstrated by hole K21-2050-216-X01A, with 8.1 feet of 2.5 ounces of gold per ton and 16.9 feet of 0.63 ounces of gold per ton. These grades are similar to the Jualin deposit but are in tellurium-type ore typically encountered in the Kensington deposit, which provides the bulk of Kensington's gold production.

## Palmer

The Palmer project near Haines is being explored by partners Constantine Metal Resources Ltd. (operator; 51 percent interest) and Dowa Metals & Mining Alaska Ltd. (49 percent interest). Palmer is an advanced-exploration-stage, zinc-copper-silver-gold-barite VMS-deposit that occurs in the same belt of rocks that hosts the Greens Creek Mine. A 2019 PEA based on a 3,800 tons-per-day, 11-year mining and processing scenario indicated pre-production capital costs of \$278 million, a pre-tax net present value of \$354 million, and a post-tax payback period of 3.3 years.

The RW and South Wall zones contain an indicated mineral resource of 5.16 million tons grading 5.23 percent zinc, 1.49 percent copper, and 0.90 ounces of silver per ton and an inferred mineral resource of 5.88 million tons grading 5.20 percent zinc, 0.96 percent copper, and 0.853 ounces of silver per ton. See appendix D for mineral resource details.

Constantine Metal Resources Ltd. announced a \$8.8 million exploration budget for 2021 and began fieldwork in June. Plans to complete 20,000 feet of drilling were modified due to drill contractor staffing issues and low drill productivity. The drilling program was downsized with a focus on environmental and geotechnical core drilling to provide the necessary environmental and hydrologic information for permitting purposes. Eight diamond drill holes were completed for a total footage of 9,570 feet.

Six geotechnical diamond drillholes (5,534.8 feet) were completed in the Palmer

deposit area to provide hydrological information including water volume and water quality, as well as to monitor water and additional hydrological studies. Two drillholes (4,035 feet) were completed on the lower South Wall Zone as resource infill and hydrological information holes. Drillhole CMR21-143B tested the lower part of the South Wall inferred mineral resource and intersected the mineralized horizon between 1,480.3 and 1,678.8 feet downhole with zones of semi-massive to massive sulfides and barite. Significant intercepts were 121.0 feet grading 0.16 percent copper, 2.16 percent zinc, 0.487 ounces of silver per ton, and 17.50 percent barite, and 22.6 feet grading 2.10 percent copper, 7.08 percent zinc, 1.185 ounces of silver per ton, and 0.012 ounces of gold per ton.

Extensive engineering and environmental studies were also completed. An avalanche study database was updated for designing avalanche mitigation requirements and longer-term safe locations for project infrastructure. A proposed portal access road construction project was reviewed for an updated cost estimate to complete the switchback road in 2022, in preparation for the 2023 planned start of the underground exploration incline.

Seismic survey work totaling 4.2 line-miles was carried out on 11 grid lines across and down Glacier Creek valley to collect depth to bedrock information, that was followed up with a sonic overburden drilling program. Twelve sonic overburden drill holes totaling 2,225.4 feet were completed in Glacier Creek valley to determine the overburden stratigraphy and establish bedrock depth. The holes will be used as groundwater monitoring wells to provide groundwater flow information for future underground exploration and infrastructure planning.

Three Glacier Creek monitoring stations were established to provide seasonal stream flow information, particularly for the peak flow periods that are difficult to acquire because of the very high energy stream environment during these periods. Two weather stations are established on

site that provide continuous temperature, precipitation, and wind information. The higher elevation station was upgraded to include precipitation data. Information from these stations is publicly available and useful for assessing avalanche hazard during the heli-skiing season.

### Big Nugget

In August 2020, Constantine announced that it identified a potential source area for the historical Porcupine gold placers about five miles east of the Palmer project. Fieldwork on the Big Nugget project in 2021 included additional soil sampling to expand and fill-in the previous wide spaced soil lines.

### Bokan Mountain

Ucore Rare Metals Inc.'s Bokan Mountain property on Prince of Wales Island, 35 miles southwest of Ketchikan, has Alaska's only defined resource of REEs. The deposit is hosted in an Early Jurassic igneous complex composed of peralkaline granitic rocks with silicate vein dikes enriched in both light and heavy REEs. The deposit is particularly rich in the more valuable and strategically important heavy REEs, with a 5.28 million ton indicated resource and a 1.16 million ton inferred resource of REEs (see appendix D for resource details).

Senior management from Ucore and Innovation Metals Corp. presented an overview of the Alaska Strategic Metals Complex (SMC) project to the AIDEA board. The AIDEA board authorized a preliminary due-diligence process for a potential \$3 million to \$5 million investment for the development and commercial-scale operation of the REE separation facility. Ucore plans to build the SMC near Ketchikan.

The Alaska SMC is a planned REE separation and processing facility that would initially process mixed REE concentrates from U.S.-allied suppliers into commercial purity REE oxides, specifically for REE permanent-magnet applications. Development of this Alaska SMC is the first step toward Ucore's larger goal of developing a mine at Bokan Mountain.

The SMC would utilize RapidSX REE and critical minerals separation technology developed by Innovation Metals Corp., a company Ucore acquired last year. According to Innovation Metals, RapidSX is more than ten times faster and much more environmentally sound than the mixer-settler units used for traditional solvent extraction separation. Innovation Metals reported that the RapidSX REE and critical minerals separation technology is on pace to be ready for commercial adoption and implementation via revenue-producing licensing agreements by the end of 2022. This includes the completion of a demonstration plant at its commercialization and development facility in Ontario, Canada.

Innovation Metals, working with researchers at the University of Toronto, is also developing and evaluating proprietary, cost-effective methods of reducing the quantity of yttrium in heavy-REE-rich feedstocks prior to separation using RapidSX. Removing this lower-value element prior to REE separation has the potential to reduce operating costs, as well to reduce the required plant size, thus reducing capital costs.

Ucore Rare Metals signed a memorandum of understanding with Vital Metals, an Australian firm with a REE mine in Canada's Northwest Territories. Vital Metals pledged to process ore at a REE extraction plant in Saskatchewan and to ship the concentrate to the SMC. The SMC will separate the REEs from the concentrate. Ucore's goal is to have the SMC complex substantially completed by the end of 2023 and operational by 2024.

Ucore completed the shipment of nearly 1,100 pounds of sorted Bokan mineralized material in April to commence the second phase of mill flowsheet development testing at SGS Canada - Lakefield. The program would finalize the Bokan mill flowsheet design based on laboratory scale results recovering REEs and the co-production of beryllium, zirconium, niobium and hafnium. The third phase of the program, to be undertaken as part of a PFS or FS, will conduct pilot-scale testing of the developed mill flowsheet utilizing additional mineralized material, and

ultimately concluding with separation and purification testing at Innovation Metals's RapidSX commercialization and development facility in Kingston, Ontario, Canada.

Ucore's team conducted field mapping work during September at Bokan Mountain to identify the two bulk sample areas and to coordinate next summer's field activities.

### Herbert Gold

Grande Portage Resources, Ltd. staged an exploration drill program at its Herbert Gold project near Juneau, a vein-hosted orogenic system that is part of the Juneau Gold Belt. The Juneau Gold Belt also includes the active Kensington Mine and the historically productive Alaska–Juneau Mine.

The company updated its mineral resource estimate for the project in May 2021. With nine veins contributing to the resource, the project now hosts 1.52 million ounces of gold at an average grade of 0.290 ounces of gold per ton (indicated plus inferred resources; app. D).

Grande Portage drilled 27,559 feet in 2021 with two drill rigs and completed 19 holes in late October into the North, Goat, Sleeping Giant, Ridge, Main, Deep Trench, Floyd and Elusive veins and numerous subsidiary veins and structures .

Drill results continue to expand high-grade zones in the Goat, Main and Deep Trench veins. Infill drilling shows potential for the Sleeping Giant Vein to expand to the west as well as to depth, and for the higher-grade zones within the Main Vein to expand to the west. Drillhole 21Q-4 intersected 4.2 feet of the Goat Vein grading 0.292 ounces of gold per ton, 7.0 feet of the Sleeping Giant Vein grading 0.450 ounces of gold per ton, and 3.0 feet of the Main Vein grading 0.610 ounces of gold per ton. The Main Vein was also intersected in drillhole 21W-1, with 11.6 feet grading 1.504 ounces of gold per ton, and in drillhole 21Q-3, with 5.8 feet grading 0.332 ounces of gold per ton. Drillhole 21Q-6 had a 3.5-foot intersection into the hanging wall

of the Goat Vein that contained visible gold and graded 2.504 ounces of gold per ton.

According to Grande Portage, mineralization in the Herbert gold vein system appears to be constrained to a competent quartz diorite block sandwiched between two major northwest-striking, moderately northeast-dipping faults which are greater than a half mile apart. Drillhole 21Z-1 penetrated the bounding fault between the quartz diorite and the metasedimentary rocks to the west. A 2.5-foot intersection averaging 0.097 ounces of gold per ton indicates that the contact fault zone may host significant gold mineralization.

An outcrop of the Hanging Wall strand of the Goat Vein was discovered on the edge of the Herbert River. A 1.48-foot-long channel sample consisted of quartz with disseminated arsenopyrite, galena, pyrite, and some visible gold grains. Geochemical results of this sample and a grab sample of the same vein were 3.367 ounces of gold per ton and 2.150 ounces of gold per ton, respectively.

### Helm Bay

Helm Bay is a historical gold mining area located on the Cleveland Peninsula about 25 miles north of Ketchikan. Surface exploration activities at Agnico Eagle (USA) Ltd.'s Helm Bay project in 2021 included collecting and analyzing 1,357 soil samples for use in geologic mapping and drill hole planning. In 2021, Agnico Eagle (USA) drilled 5,955 feet of oriented core in 14 shallow angle holes. All core was sampled and analyzed for geochemistry, and geologists conducted structural data analysis and modeling of down hole structural data.

### Niblack

Niblack is an advanced-exploration-stage copper–gold–zinc–silver project on Prince of Wales Island, approximately 27 miles southwest of Ketchikan. The property hosts six known zones of VMS mineralization, including the Lookout and Trio deposits, which host a combined total of almost 10 million tons of mineralization grading

0.8 percent copper, 1.3 percent zinc, 0.04 ounces of gold per ton, and 0.59 ounces of silver per ton (app. D). The property is owned and explored by Blackwolf Copper and Gold Ltd. (formerly Heatherdale Resources Ltd.).

Blackwolf rehabilitated 0.62 miles of underground workings to facilitate the 2021 drilling program. Five holes totaling 5,938 feet of NQ2 core were completed in April 2021 using underground diamond drills operated by Morecore Drilling of Stewart, BC. Resource expansion drilling intersected much wider intervals than expected from previous modelling, with consistent polymetallic grades within the Lookout Zone. Highlights of the drilling at the Lookout and Lookout Extension zones include hole U21-226 with 88.58 feet averaging 1.06 percent copper, 1.04 percent zinc, 0.055 ounces of gold per ton, and 0.959 ounces of silver per ton. Hole U21-227 intersected 106.96 feet of mineralization averaging 1.03 percent copper, 0.92 percent zinc, 0.044 ounces of gold per ton, and 0.775 ounces of silver per ton.

Exploration drilling down-dip of the deposit encountered encouraging base and precious metal intervals within the prospective massive sulfide horizon. Drill holes U21-225 and U21-228 encountered broad intervals of disseminated and stringer sulfide mineralization, primarily pyrite. Drillhole U21-229 testing up-dip extensions of mineralization was stopped short of the mineralized horizon.

In 2021, Blackwolf made a significant geological breakthrough on the Niblack property by confirming that the folded volcanic stratigraphy was overturned. This new interpretation opened up significant areas of prospective stratigraphy for exploration and resource expansion.

## Hyder

Blackwolf Copper and Gold Ltd. staked claims during 2021 on numerous historical, high-grade gold-silver prospects and mines near Hyder and on the Alaska side of British Columbia's famed Golden Triangle. Blackwolf

staked the Texas Creek, Cantoo, and Casey claim groups, totaling almost 11,000 acres and 474 federal mining claims. Porphyry, VMS, and other intrusion-related mineral deposits in the area are dominantly hosted in Jurassic Hazelton Group rocks associated with coeval intrusions, with commonly overprinting Eocene epithermal-style vein-dominated mineralization.

Blackwolf's 2021 field program consisted of three weeks of fly-camp-supported reconnaissance mapping and sampling. Geologists completed one-to-2,500-scale structural and stratigraphic mapping and collected 243 rock samples across the Texas Creek and Cantoo properties. Surface sampling was centered on evaluating historical mines and prospects, including Cantoo, Solo, Silver King, Double Anchor, Blasher, Doghole, and Iron Cap showings, all of which have seen almost no modern-day exploration. Assay results for the 243 rock samples collected during 2021 ranged from trace to 0.888 ounces of gold per ton, trace to 230.972 ounces of silver per ton, trace to 5.8 percent copper, trace to 22.4 percent zinc and trace to greater than 20 percent lead. Twenty-five of 243 rock samples returned over 0.03 ounces of gold per ton.

Blackwolf made a number of discoveries across their Hyder properties. A series of stacked gold-mineralized quartz veins up to 100 feet wide were traced for 1,600 feet along strike at the Cantoo prospect. Quartz veining and alteration associated with high-grade silver mineralization at the Solo prospect was traced for 1,750 feet of strike length. Multiple areas of intrusive-related disseminated to massive sulfide mineralization, shearing and quartz-sulfide veining were found proximal to Texas Creek intrusive rocks at the Doghole prospect. A number of high-grade, gold and silver bearing veins were also discovered at the Texas Creek property.

Two reconnaissance soil lines, totaling 100 soil samples, were also completed on the Cantoo property and at the Blasher prospect on the Texas Creek property. No results were announced.



## Apex El Nido

The Apex high-grade gold prospect is located on the northern portion of Chichagof Island, near the community of Pelican, approximately 75 miles west-southwest of Juneau. The property consists of 39 unpatented federal mining claims on National Forest lands totaling approximately 780 acres. The Apex Mine, with four levels of underground workings totaling 3,900 feet, produced approximately 18,000 ounces of gold and 2,400 ounces of silver from 1923 to 1936 at an average grade of 1.4 ounces of gold per ton.

Millrock Resources Inc. controlled the property and entered into an agreement with Coeur Explorations, Inc. in 2021 to exercise an option to earn a 100 percent interest in the claims through staged payments and exploration expenditures. Coeur agreed to fund approximately \$200,00 of exploration work.

The exploration work was completed during August 2021 and consisted of a 439-sample, soil geochemical survey, rock sampling, and geologic mapping. Soil samples were collected along a 65-foot by 131-foot spaced grid. The soil survey was designed to test the presence and extent of gold-bearing quartz veins along strike and down-valley from known gold mineralization at the historical Apex and El Nido mines.

A broad gold in soil anomaly was outlined by the geochemical survey in the lower cirque valley of Cann Creek. Soil sample results ranged from below detection to a maximum of 1.09 ounces of gold per ton and 1.10 ounces of silver per ton. One hundred and seven of the 439 samples collected were considered highly anomalous. The anomaly occurs at approximately 1000 feet in elevation below outcropping vein exposures that host the Apex Mine and extends over



**Photo 11.** Geologist conducts fieldwork at Apex gold prospect. Photo: Millrock Resources Inc.

three thousand feet down-valley from the historical workings, along strike of the vein swarm. The anomaly is also underlain by the same rock units (diorite and amphibolite) that hosts the Apex vein.

Coeur elected to terminate the option agreement after the 2021 field season.

### **Snettisham**

Resolution Minerals Ltd. divested the Snettisham iron-vanadium project to Millrock Resources Inc. on a share of proceeds agreement. There was no subsequent news about the project.

## **Alaska Peninsula Region**

### **Unga**

Heliostar Metals Ltd. (formerly Redstar Gold Corp.) continued an exploration drill program at its Unga epithermal gold-silver project in 2021. The project includes the past-producing Apollo and Sitka mines and the Shumagin, Centennial, and Aquila prospects on Unga and Popof islands. The Apollo Mine was Alaska's first underground gold mine, producing an estimated 130,000 ounces prior to its closure in 1922. The SH-1 Vein has an inferred resource of 384,300 ounces of gold at an average grade of 0.40 ounce of gold per ton, and 986,300 ounces of silver at a grade of 1.03 ounces of silver per ton (app. D).

In the first half of 2021, Heliostar carried out a drill program on the Unga project. One rig drilled 6 core holes and 55 RC holes were drilled by two rigs. Drilling tested the SH-1 resource,

the Apollo Mine-Sitka Mine area, the Aquila prospect and district prospects at Zachary Bay and Orange Mountain. Drill highlights from the Apollo-Sitka area include drillhole APSRC21-02 with 10 feet grading 2.578 ounces of gold per ton, and drillhole APSRC21-08 with 10 feet grading 0.164 ounces of gold per ton. Drillhole SKRC21-03 intersected 15 feet of 0.233 ounces of gold per ton, 15 feet of 0.564 ounces of gold per ton and another 15-foot intersection grading 0.298 ounces of gold per ton. Drill results from the two reverse-circulation holes at the Zachary Bay target were much lower grade, but had longer intersections, with up to 300 feet grading 0.010 ounces of gold per ton.

The Aquila prospect, with outcrops of epithermal quartz veins, is within the Shumigan vein corridor and about three miles southwest of the SH-1 resource area. In 2021, thirteen RC holes were completed at the Aquila target and all holes intersected the Amethyst Vein. The Amethyst Vein now has a drill defined minimum strike length of 1,500 feet. Two separate zones along the vein contain higher-grade gold mineralization and both remain open for expansion with follow-up diamond drilling. Highlights from the 2021 drill campaign at the Aquila prospect include 0.190 ounces of gold per ton for a 10-foot intersection in hole AQRC21-09, and 0.289 ounces of gold per ton for a 5-foot intersection in hole AQRC21-01.

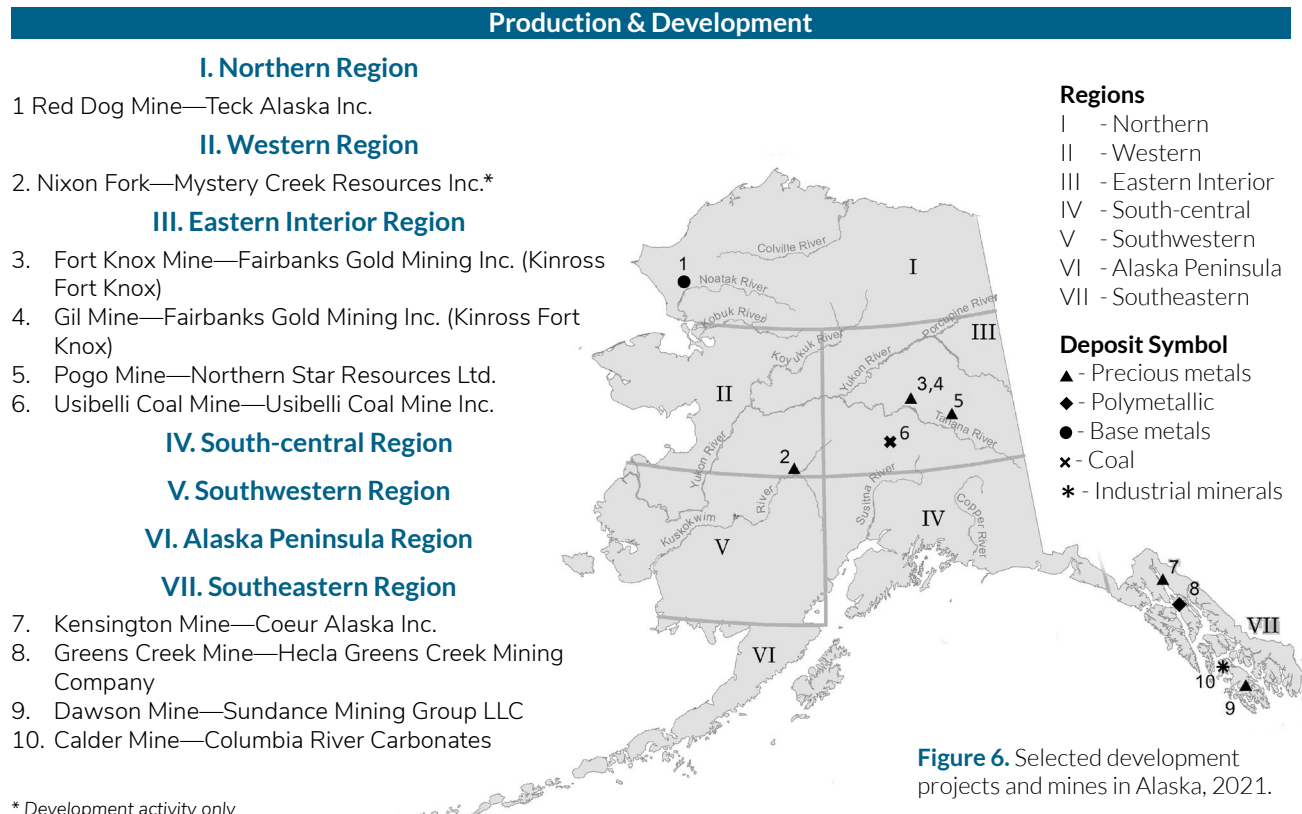
## DEVELOPMENT AND PRODUCTION

Mining development expenditures in Alaska increased 27 percent to \$339.1 million in 2021 (table 13). Projects and capital expenditures delayed in 2020 due to the pandemic were advanced with strong mitigation measures. Alaska's seven large operating mines reported development expenditures (fig. 6). Currently, only capital expenditures at Alaska's large operating mines are contributing to this category, which is sensitive to the timing of high-cost individual projects. Placer mining and quarry development expenditures are not tabulated in this report. Development expenditures for placer and sand and gravel operations are believed to be minor compared to the large mines. Expenditures of permitting-stage projects are tabulated in the exploration section of this report.

Development and production estimates in this report are compiled from a variety of online sources, including annual reports, financial reports, and news releases by mining companies; and data collected by federal government

agencies. The public information is supplemented by questionnaires returned to DGGs by mining companies, as well as personal communications.

Over the past 10 years, most development work has been conducted at mine sites; there have been few purely development-stage projects. The development sector of the mining process refers to building infrastructure or conducting activities that facilitate production of mineral products. Development expenditures reflect actual expenditures at mines as well as sustaining capital. Sustaining capital includes equipment replacement and rebuilding, facility upgrades, and other expenditures that must be amortized or depreciated in accordance with tax laws, and thus, are frequently reported as distinct line items in securities filings. Development activities, whether to build a new mine or make improvements to an existing mine, are often precursors to increased annual production or extended mine life. Production expenditures include those costs directly related to the production of metals.



**Figure 6.** Selected development projects and mines in Alaska, 2021.

\* Development activity only

**Table 13.** Reported mineral development expenditures in Alaska by commodity, 1982–2021.

Year	Base Metals	Polymetallics <sup>a</sup>	Precious Metals	Gemstones <sup>b</sup>	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 <sup>a</sup>	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 <sup>b</sup>	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 <sup>c</sup>	W	W	188,226,940	-	-	-	309,938,884
2016	W	47,046,279	133,243,900	-	-	W	217,376,728
2017	W	35,254,986	209,082,444	-	-	W	299,502,316
2018	W	46,863,810	156,263,106	-	-	W	334,112,057
2019	W	35,830,809	184,097,276	-	-	W	347,822,085
2020	W	28,797,676	192,624,758	-	-	W	267,765,434
2021	W	27,580,819	173,969,455	-	-	W	339,089,131
<b>Total</b>	<b>\$ 1,096,081,545</b>	<b>\$ 788,032,818</b>	<b>\$ 4,863,793,804</b>	<b>\$ 1,670,250</b>	<b>\$ 42,749,261</b>	<b>\$ 120,511,544</b>	<b>\$ 7,691,333,068</b>

<sup>a</sup>Polymetallics category added in 1986.

<sup>b</sup>Gemstone development category added in 2009.

<sup>c</sup>Significant development expenditures were not reported for precious metals in 2015.

- = Not reported

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

Average metal prices used in this report are based on the average daily London Metal Exchange price (table 14). 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

**Table 14.** Average metal prices, 1996–2021.

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 <sup>a</sup>	972.35	14.67	2.35	0.78	0.75
2010 <sup>a</sup>	1,224.53	20.19	3.42	0.97	0.98
2011 <sup>a</sup>	1,571.52	35.12	3.99	1.09	0.99
2012 <sup>a</sup>	1,668.98	31.15	3.61	0.93	0.88
2013 <sup>ab</sup>	1,411.23	23.79	3.32	0.97	0.87
2014 <sup>ab</sup>	1,266.40	19.78	3.11	0.95	0.98
2015 <sup>ab</sup>	1,160.06	15.68	2.50	0.81	0.88
2016 <sup>ab</sup>	1,250.74	17.14	2.21	0.85	0.95
2017 <sup>ab</sup>	1,257.12	17.04	2.80	1.05	1.31
2018 <sup>ab</sup>	1,268.49	15.71	2.96	1.02	1.33
2019 <sup>ab</sup>	1,392.60	16.21	2.72	0.91	1.16
2020 <sup>ab</sup>	1,769.64	20.55	2.70	0.82	1.01
2021 <sup>ab</sup>	1,797.24	25.11	4.23	1.00	1.36

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

<sup>a</sup>2009–2021 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.

<sup>b</sup>2013–2021 copper, lead, and zinc prices from U.S. Geological Survey Mineral Commodity Summaries, based on London Metal Exchange (LME), and LME average daily settlement.

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 consider shipping, smelting, refining, and other costs incurred by the producer; and may significantly overestimate the actual value of the material.

Alaska's 2021 mine production provided \$2.82 billion in estimated revenue to mineral producers. Alaska's metal mines benefited from rising gold, silver, zinc, and lead prices in 2021. Coal production held steady. The total revenue realized by Alaska producers increased by one percent (\$2.8 billion; tables 1 and 15).

The USGS estimated that the 2021 value of non-fuel mineral production in Alaska was \$3.89 billion, ranking sixth among the 50 states and accounting for 4.30 percent of the U.S.'s total mineral production in 2021. The estimated revenue to Alaska's mineral industry for non-fuel mineral production for 2021 in this report was \$2.77 billion. This estimated revenue value accounts for actual sale prices and includes smelting, refining, and transportation costs.

Zinc remains the state's leading mineral product, having a reported production value of \$1.65 billion in 2021. Zinc accounted for 47 percent of Alaska's metal production value, and gold accounted for 34 percent (fig. 7). The annual value of zinc production has exceeded that of gold since 2014 (app. B). Production of lead was slightly lower in 2021, and silver production dropped by more than one million ounces from the 2020 production volume (table 15).

Gold production from lode mines in the eastern Interior and Southeastern regions totaled 632,302 ounces in 2021, of which 70 percent was produced from the Fort Knox and Pogo gold mines in the eastern Interior region (fig. 8). Kensington gold and Greens Creek polymetallic mines in Southeastern Alaska, the third and fourth largest gold producers, along with the Dawson Mine accounted for the remainder of lode gold production. Placer gold production in 2021 is estimated at 42,391 ounces (table 16).

**Table 15.** Estimated mineral production in Alaska, 2019–2021.<sup>a,b</sup>

Metals	Production Volume			Production value (\$)		
	2019	2020	2021	2019	2020	2021
Gold (ounces)	589,080	651,418	674,693	\$ 802,502,161	\$ 1,105,445,191	\$ 1,212,585,247
Silver (ounces)	17,674,583	17,997,209	16,714,807	258,052,067	321,364,224	419,708,804
Lead (tons)	133,424	128,875	127,208	233,202,741	199,206,769	254,416,000
Zinc (tons)	665,889	597,718	608,395	1,486,128,992	1,164,745,504	1,654,834,400
<b>Subtotal</b>				<b>\$ 2,779,885,961</b>	<b>\$ 2,790,761,688</b>	<b>\$ 3,541,544,451</b>
<b>Industrial Minerals</b>						
Sand and gravel (million tons) <sup>c</sup>	7.5	6.7	6.2	\$ 65,200,000	\$ 56,900,000	\$ 54,400,000
Rock (million tons)	1.6	1.6	0.9	\$ 26,600,000	\$ 13,400,000	\$ 8,900,000
<b>Subtotal</b>	<b>9.1</b>	<b>8.3</b>	<b>7.0</b>	<b>\$ 91,800,000</b>	<b>\$ 70,300,000</b>	<b>\$ 63,300,000</b>
<b>Coal and Peat</b>						
Coal (tons) <sup>d</sup>	1,000,000	1,020,870	1,042,288	\$ 35,000,000	\$ 51,043,500	\$ 52,114,400
Peat (cubic yards)	-	-	-	-	-	-
<b>Subtotal</b>				<b>\$ 35,000,000</b>	<b>\$ 51,043,500</b>	<b>\$ 52,114,400</b>
<b>Total</b>				<b>\$ 2,906,685,961</b>	<b>\$ 2,912,105,188</b>	<b>\$ 3,656,958,851</b>

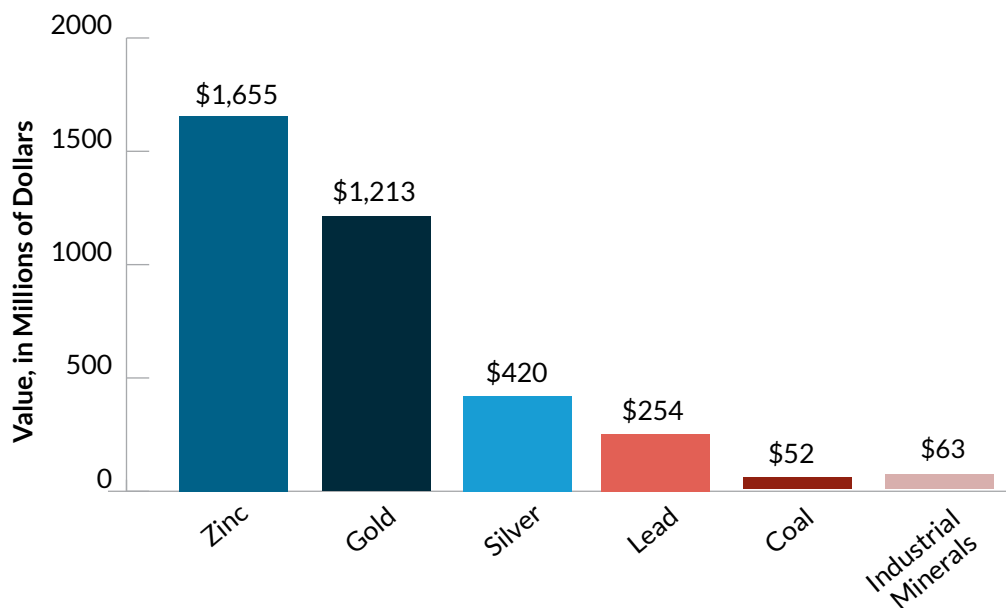
<sup>a</sup> Production data from DGGs questionnaires, Internet research, interviews with operators, DOT&PF, and municipalities, regional corporations, and Federal land management agencies.

<sup>b</sup> 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.

<sup>c</sup> Industrial minerals (rock, sand, and gravel) quantities and values for 2019 and 2020 are revised from previously reported amounts.

<sup>d</sup> Coal price assumption for revenue was updated from \$35 to \$50 per ton

starting in 2020. This estimate is based on a coal price of \$3.37 per million BTU published for Alaska by the U.S. Energy Information Administration (<https://www.eia.gov/state/print.php?sid=AK>; last accessed November 15, 2021) and a heat value of 7,560 BTU per pound reported by Usibelli (<http://www.usibelli.com/coal/data-sheet>, last accessed January 13, 2022). 2019 Usibelli Coal Mine coal production revised from Table 1, Energy and Economic Impacts of Coal in Interior Alaska, January 2022 (<http://www.usibelli.com/pdf/2022-Economic-Impacts-of-Coal.pdf>, last accessed February 13, 2024). 2020 coal production for Usibelli coal mine was reported by MSHA (<https://arweb.msha.gov/OpenGovernmentData/DataSets/MinesProdYearly.zip>).

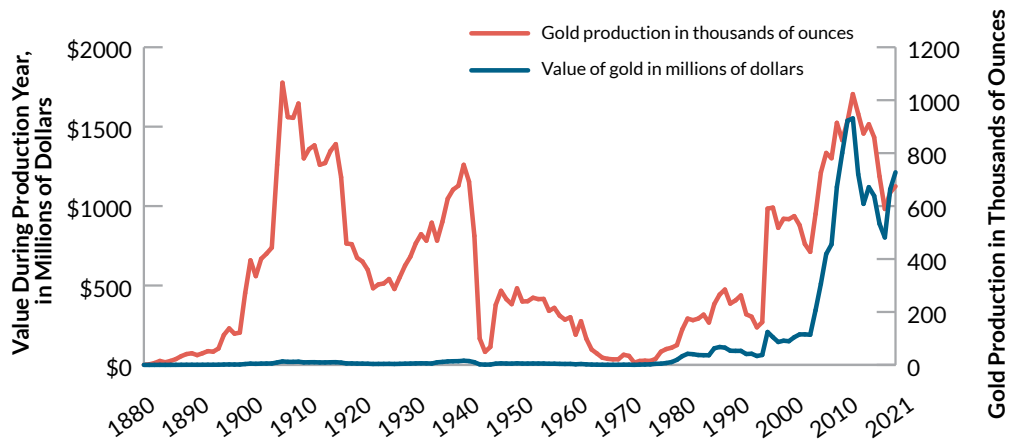


**Figure 7.** Estimated 2021 mineral production in Alaska by commodity.

According to USGS data, Alaska companies produced 889,000 tons of crushed stone in 2021, valued at \$8.90 million. There were 16 active crushed-stone operations with 15 active quarries during 2021. The total value of sand and gravel produced in 2021 was \$54.4 million from 6.15 million tons of material. There were 70 active sand and gravel operations during 2021 with 137 active pits and five dredging operations. The value and volume of Alaska's industrial minerals (rock, sand, and gravel) produced in 2021 is shown in figure 9 and tabulated in appendix C.

The total estimated volume of industrial minerals sold from state-owned lands is 1.2 million tons. Sales of industrial minerals dropped by 20 percent compared to the 1.5 million tons of sales volume in 2020. The sales volume value includes data from all three DNR land offices (table 17), of which the northern region accounted for 83 percent of production. The 2021 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

**Figure 8.** Historical gold production in Alaska, 1880-2021, and corresponding market value.



**Table 16.** Production and employment estimates for Alaska placer gold mines, 2015–2021. Prior-year data for 2015–2019 are not updated in this table to maintain consistency with calculations and other tables in this report.<sup>a</sup>

	2015	2016	2017	2018	2019	2020	2021
Number of placer operations reporting gross operating income <sup>a</sup>	236	205	192	169	150	148	148
Total gross operating income reported <sup>a</sup>	\$64,803,637	\$51,912,476	\$76,985,791	\$66,845,710	\$57,514,359	\$79,117,239	\$59,033,363
Average yearly price of gold <sup>b</sup>	\$1,160.06	\$1,250.74	\$1,257.12	\$1,268.49	\$1,392.60	\$1,769.64	\$1,797.24
Estimated number of gold ounces produced	55,862	41,505	61,240	52,697	41,300	44,708	42,391
Estimated number of full-time-equivalent employees	222	193	181	159	141	139	139

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, <https://www.dropbox.com/s/wly4yrnmlop59on/AMA%20Placer%20Final%20Report%2011.15.pdf?dl=0>. The factor takes in 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.

<sup>a</sup> Values provided by the Department of Revenue. Updated figures for prior years include: in TY 2015, 220 operations reported income of \$63,607,692; in TY 2016, 202 operations reported income of \$53,097,504; in TY 2017, 196 operations reported income of \$77,286,581; in TY 2018, 168 operations reported income of \$66,808,408; and in TY 2019, 154 operations reported income of \$58,144,314.

<sup>b</sup> 2015–2021 gold prices from Kitco cumulative average London PM fix.

minerals on private, Native, and other federal lands, as tabulated above by the USGS.

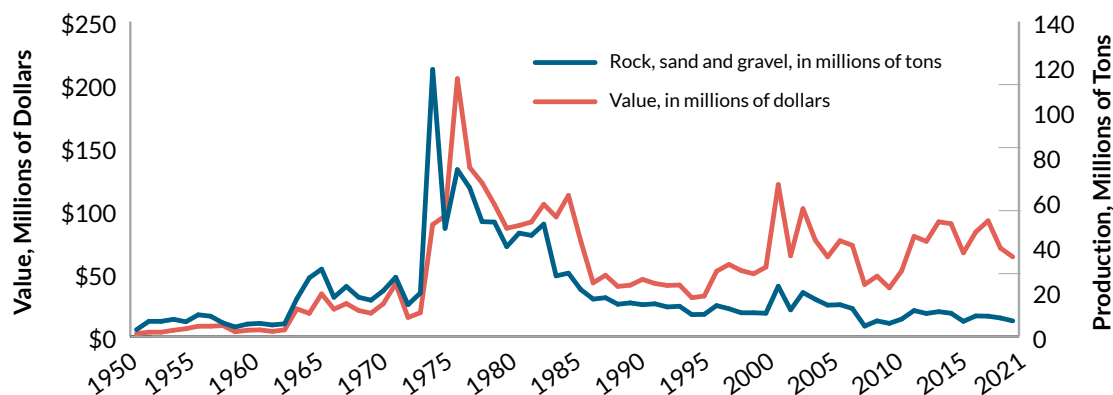
In 2021, there were 409 active Application for Permits to Mine in Alaska (APMA) for placer mining, 93 for suction dredging, and 77 for active hardrock exploration.

The 2021 value of Alaska mineral exports was \$2.67 billion, an increase of 55 percent from 2020 (table 18). Mineral and ore concentrates were worth \$2.13 billion, or 80 percent of the mineral export value. Minerals and ores are the second-highest export sector for Alaska, after fish and marine products. Total exports include copper–gold concentrates from the Minto Mine in Yukon, Canada, that were shipped through the AIDEA-owned terminal in Skagway. Usibelli Coal Mine did not export coal outside of Alaska in

2021 (fig. 10). Alaska exported ores, concentrates, and other mining products worth \$515 million to Canada, \$394 million to South Korea, \$366 million to Europe, \$311 million to Japan, \$266 million to China, and \$156 million to Australia.

### Red Dog Mine

Red Dog Mine in northwestern Alaska is one of the world's largest sediment-hosted massive sulfide zinc deposits. NANA Regional Corporation (NANA), a regional Alaska Native corporation, owns the Red Dog deposit and surrounding lands. Teck Alaska Inc. is the Red Dog Mine operator of the open-pit, truck-and-loader operation that uses conventional drill-and-blast mining methods. Power for the mine is produced on-site by diesel generators with a maximum capacity of 30 megawatts.



**Figure 9.** Rock, sand, and gravel production in Alaska, 1950–2021.

**Table 17.** 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 2012–2021. 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	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Northern (Fairbanks office)	3,501,387	4,991,349	9,247,223	3,559,580	4,989,855	3,501,847	2,466,002	1,918,082	1,350,906	1,006,876
South-Central (Anchorage office)	1,035,450	235,050	433,433	2,115,750	396,657	396,657	143,597	529,894	163,574	176,004
Southeast (Juneau office)	56,115	69,866	62,559	50,211	13,268	13,268	30,173	32,957	3,921	33,703
<b>Total Tons</b>	<b>4,592,952</b>	<b>5,296,265</b>	<b>9,743,214</b>	<b>5,725,541</b>	<b>5,399,780</b>	<b>3,911,772</b>	<b>2,639,771</b>	<b>2,480,933</b>	<b>1,518,401</b>	<b>1,216,583</b>

Source: Department of Natural Resources, Division of Mining, Land and Water Southeast Regional Office (SERO), South-Central Regional Office (SCRO), and Northern Regional Office (NRO) Material Sale Tracking Spreadsheets. DNR material sales volumes and revenues do not correlate, as volumes are

attributed to the calendar year in which material was extracted while revenues are tracked on a cash basis (when received), which could be in the subsequent calendar year.



**Table 18.** Alaska international mineral export values (in millions of dollars).

Year	Mineral Ores and Concentrates <sup>a</sup>	Canada Copper Ores through Skagway Terminal <sup>b</sup>	Precious Metals <sup>c</sup>	Coal <sup>d</sup>	Total Value of Mineral Exports
1996	\$ 249	-	> \$1	\$ 27	\$ 276
1997	369	-	> \$1	26	395
1998	317	-	> \$1	8	325
1999	359	-	> \$1	15	374
2000	293	-	1	16	310
2001	329	-	3	17	349
2002	380	-	47	9	436
2003	413	-	84	4	501
2004	505	-	110	14	629
2005	511	-	132	14	657
2006	1,094	-	110	10	1,214
2007	1,269	\$ 16	132	5	1,406
2008	691	103	144	23	858
2009	853	64	153	33	1,039
2010	1,336	37	214	25	1,575
2011	1,809	199	267	31	2,107
2012	1,502	169	84	32	1,618
2013	1,495	150	22	27	1,543
2014	1,750	186	11	17	1,778
2015	1,467	99	7	5	1,479
2016	1,523	146	26	2	1,551
2017	1,794	1	13	0	1,807
2018	1,773	43	7	0	1,780
2019	1,637	33	274	0	1,911
2020	1,358	66	367	0	1,725
2021	2,126	79	544	0	2,670

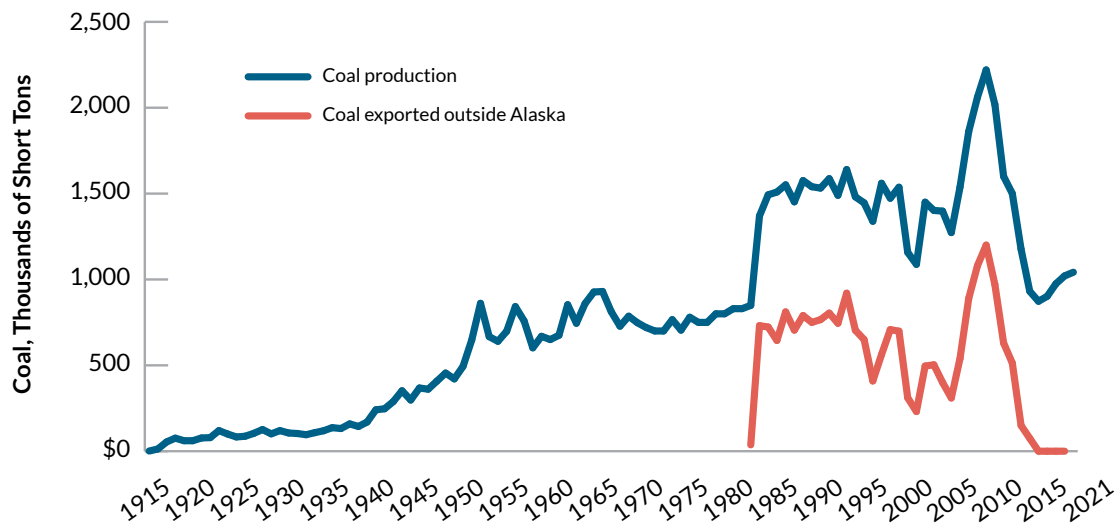
Sources: 1996–2013, 2018–2021, U.S. Census Bureau, Origin of Movement Series via USA Trade Online <https://usatrade.census.gov/>; 2014–2017, Alaska Office of International Trade

<sup>a</sup>HS 26 Mineral Ores: Zinc ores and concentrates, lead ores and concentrates, copper ores and concentrates, silver ores, gold ores and concentrates, zirconium ore (only in

2009), and miscellaneous ores.

<sup>b</sup>Value of Canada copper ores moving through Skagway that are included in Mineral Ores and Concentrates

<sup>c</sup>HS 71 Precious Metals: Gold doré, precious stones, and wrought jewelry  
<sup>d</sup>HS 27 Coal



**Figure 10.** Alaska coal production and exports, 1915–2021.

Mineral-processing facilities at the site 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 the AIDEA.

The Red Dog deposits are comprised of several sedimentary hosted exhalative lead-zinc sulfide deposits hosted in Mississippian-to-Pennsylvanian-age sedimentary rocks. The orebodies are lens-shaped and occur within structurally controlled (thrust fault) plates, are relatively flat-lying, and are hosted by marine clastic rocks (shales, siltstones, turbidites) and lesser chert and carbonate rocks. Barite-bearing rock is common in and above the sulfide units. Silicification is the dominant alteration type. The sulfide mineralization consists of semi-massive to massive sphalerite, pyrite, marcasite, and galena. Common textures within the sulfide zone include massive, fragmental, veined, and, rarely, sedimentary layering.

The Red Dog Mine is the U.S.'s leading producer of zinc and lead and has the second largest silver output in the country. The mine is currently the world's largest zinc producer.

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 2021 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 make up about 20 percent of the mill feed through 2027.

A fatal incident occurred on a production drill rig at the Red Dog Mine on the evening of January 16, 2021, resulting in the death of a 47-year-old employee. No other employees or contractors were injured, and there was no ongoing safety or environmental risk. All appropriate authorities were notified and the MSHA is conducting an investigation into the incident.

Teck projected 2021 capital costs for the Red Dog Mine of approximately \$127 million, including sustaining, growth, and capitalized stripping costs. No resource evaluation holes were drilled at the Red Dog Mine in 2021.

In 2021, zinc production at the Red Dog Mine increased to 554,747 tons, compared to 540,904 tons produced in 2020 (table 19), primarily due to higher mill throughput, supported by continuous optimization of mill performance, including RACE21™ advanced process control improvements. The zinc grade averaged 14.3 percent, with an 81.4 percent recovery rate. 2021 lead production of 107,335 tons was similar to the previous year's production of 107,475 tons. The lead grade in 2021 averaged 4.2 percent with a 53.0 percent recovery rate. In 2021, Teck employed approximately 750 full-time staff (including contractors), mined 12,005,188 tons of material, milled 4,771,660 tons of material, and sold 982.3 million pounds of zinc and 214.9 million pounds of lead.

Teck's gross profit in 2021 from the Red Dog Mine was \$678 million compared with \$513 million in 2020 and \$696 million in 2019. The increase in gross profit in 2021 compared with 2020 was primarily due to higher zinc prices that were partially offset by lower sales volumes, and by higher royalty costs, which are tied to increased profitability at the Red Dog Mine. In accordance with the operating agreement between Teck and NANA governing the Red Dog Mine, Teck pays a royalty on net proceeds of production each quarter. This royalty increases by five percent every fifth year, to a maximum of 50 percent. The most recent increase occurred in October 2017, bringing the royalty to 35 percent. The NANA royalty expense in 2021 was \$255 million, compared with \$175 million in 2020. Approximately 60 percent of these royalties are ultimately redistributed to other Alaska Native regional corporations as dictated by section 7(i) of ANCSA.

Teck transported 1,152,799 wet tons of zinc concentrate and 213,503 wet tons of

**Table 19.** Red Dog Mine production statistics, 1989–2021.<sup>a</sup>

Year	Tons Milled	Ore Grade			Total Tons Concentrate Produced <sup>b</sup>	Contained Tons Zinc	Contained Tons Lead	Million Ounces Silver <sup>c</sup>	Employees <sup>d</sup>
		Zinc (%)	Lead (%)	Silver (oz/ton)					
1989	33,300	20.4	7.6	3.6	8,532	-	-	-	228
1990	996,700	26.5	8.5	3.6	443,600	191,981	31,187	1.6	350
1991	1,599,300	22.5	6.6	2.8	521,400	234,510	43,815	1.46	331
1992	1,582,000	19.9	6.0	2.9	474,900	231,363	15,960	1.38	349
1993	1,874,600	18.4	5.7	2.8	539,800	255,149	24,788	1.51	376
1994	2,339,500	18.8	5.7	2.8	658,000	328,160	32,775	1.84	391
1995	2,485,900	19.0	5.8	2.8	753,600	358,676	55,715	3.62	397
1996	2,312,600	18.7	5.0	2.8	765,300	357,680	65,886	4.3	417
1997	2,127,000	20.3	5.2	2.9	799,400	373,097	69,284	4.27	479
1998	2,752,587	21.4	5.2	2.7	1,015,773	490,461	80,193	5.2	466
1999	3,282,788	21.3	5.2	2.7	1,207,160	574,111	97,756	6.21	539
2000	3,365,508	21.0	4.7	2.5	1,211,539	585,030	91,557	5.84	536
2001	3,560,430	19.8	5.0	2.5	1,215,837	570,980	105,000	5.9	559
2002	3,489,600	21.1	5.4	2.7	1,366,480	637,800	118,880	6.75	560
2003	3,476,689	21.7	6.2	3.1	1,410,892	638,569	137,679	7.7	388
2004	3,249,613	22.0	6.0	3.0	1,337,545	610,900	128,970	7.22	508
2005	3,402,831	21.7	5.6	3.0	1,330,717	626,112	112,766	1.97	449
2006	3,569,280	20.6	6.1	3.0	1,378,384	614,538	136,135	7.62	457
2007	3,726,910	20.2	6.1	3.1	1,428,014	633,511	146,152	11.55	459
2008	3,306,934	20.1	6.0	3.1	1,273,885	567,911	135,143	7.5	475
2009	3,729,119	20.9	5.9	3.1	1,445,870	642,096	144,954	8.12	413
2010	3,937,456	18.2	5.4	3.1	1,300,694	593,043	121,144	6.78	550
2011	4,048,000	19.1	5.0	3.0	1,182,060	572,208	84,033	5.19	586
2012	3,941,000	18.2	4.6	3.0	1,134,415	529,157	95,282	5.89	530
2013	4,243,899	17.0	3.9	NA	1,271,221	607,704	106,594	6.1	550
2014	4,739,302	16.6	4.4	NA	1,409,511	656,971	135,032	7.56	639
2015	4,437,950	14.1	2.9	NA	1,351,221	625,004	129,630	6.7	630
2016	4,684,823	17.1	4.9	NA	1,411,029	642,647	134,813	7.34	600
2017	4,706,864	15.5	5.0	NA	1,322,302	597,342	122,687	7.7	715
2018	4,882,100	15.7	4.4	NA	1,371,264	642,868	108,467	7.0	700
2019	4,692,680	15.4	4.4	3.2	1,320,809	609,084	113,312	7.8	700
2020	4,625,293	14.2	4.0	NA	1,245,107	540,904	107,475	7.5	775
2021	4,771,660	14.3	4.2	NA	1,365,918	554,747	107,335	7.45	750
<b>Total</b>	<b>109,974,216</b>				<b>36,272,179</b>	<b>16,694,313</b>	<b>3,140,398</b>	<b>184.57</b>	

<sup>a</sup>Revised slightly from Special Report 51, *Alaska's Mineral Industry 1995*, based on new company data.

<sup>b</sup>Totals for years 1990 through 1995 include bulk concentrate. Total for 2013 estimated from total metal produced for 2013. Beginning in 2020, this value is the concentrate shipped for the production year, which ended October 30, 2021 for the 2021 production year.

<sup>c</sup>Estimate calculated at 56 ounces per ton of lead metal produced from 1990 to 2004 and 2006; as reported credit for 2005, net of treatment charges; calculated at 3.1 ounces per ton of ore for 2007; estimated as proportional

with increase in zinc and lead in 2013; as reported in 2014, 2016, 2017, and 2019; calculated based on recoverable silver from reported lead concentrate recovered in 2015; in 2018, 2020, and 2021 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.

<sup>d</sup>Includes contract employees, if known.

- = No concentrate produced

NA = Not available

lead concentrate along the AIDEA's DeLong Mountain Transportation System to the port facilities through December 31, 2021.

The 2021 Red Dog concentrate shipping season began on July 19, 2021, one of the latest starts in the last decade, following delays due to weather and ice conditions, and was completed on October 30, 2021. A total of 1,239,490 wet tons of concentrate were shipped in the 2021 season. As a result of the late start to the season and shipping delays associated with record weather disruptions in July and August, a portion of concentrate sales were deferred to 2022.

In 2021, the majority of the zinc concentrate produced at the Red Dog Mine was shipped to customers in Asia, Australia, and Europe, with the balance shipped to Teck's metallurgical facilities at Trail, British Columbia, Canada. Red Dog's lead concentrate production was also shipped to Trail and to customers in Asia, Australia, and Europe. The Trail refinery recovered undisclosed amounts of silver from the Red Dog Mine lead concentrate and undisclosed amounts of by-product germanium in the form of dioxide and tetrachloride from the Red Dog Mine zinc concentrate. DGGs estimates that silver production is 7.45 million ounces (table 19) and by-product germanium production could be as high as tens of tons.

Red Dog Mine's production of contained metal in 2022 is anticipated to be in the range of 595,000 to 628,000 tons of zinc and 88,000 to 99,000 tons of lead. From 2023 to 2025, zinc production is expected to be in the range of 562,000 to 606,000 tons of contained zinc per year, while lead production is expected to be between 94,000 and 105,000 tons of contained lead per year.

## Fort Knox Mine

The Fort Knox 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

from the plutonic rock host. Fort Knox Mine's 2021 production totaled 264,283 gold-equivalent ounces, an 11 percent increase over 2020, attributable to the increased volume of ore mined and processed. The mine employed an average of approximately 650 workers during the year. The Fort Knox Mine celebrated the 25th anniversary of operations in December 2021.

The Fort Knox Mine was the fifth-largest gold producer in the U.S. during 2021, and mined 38.5 million tons of ore, processed 8.9 million tons through the mill, and placed 32.9 million tons on two heap leach pads (table 20). Mill grade averaged 0.020 ounces of gold per ton with an 81.1 percent recovery rate. The heap leach grade averaged 0.006 ounces of gold per ton. Compared to 2020, tons mined increased by 22 percent, total tons processed (including ore placed on heap leach pads) increased by 14 percent, and mill feed grade increased by two percent. These increases resulted from the planned mining sequence, with continued mining of Phase 8 and 9 ores and beginning mining of Phase 10 ore.



**Photo 12.** Gold pour at Fort Knox Mine. Photo: Kinross Gold Corp.

Production cost of sales was \$267.2 million in 2021, compared to \$251.3 million in 2020. Capital expenditures totaled \$113.1 million in 2021. Depreciation, depletion, and amortization expenses totaled \$109.8 million.

Fort Knox Mine's positive results were largely a result of lower-cost ounces recovered from the new Barnes Creek heap leach facility after construction was completed at the Gilmore

project in early 2021. The Gilmore project is a westward expansion of the Fort Knox Mine pit. It is expected to add more than 2 million ounces of gold to the mine's overall production and extend mine life to 2028. Total reserves and resources stood at 4.8 million ounces at year-end (app. D).

Earthwork and a liner were completed as part of the stage 2 work at the Barnes Creek heap leach facility. During the summer of 2021, the water

**Table 20.** Fort Knox Mine production statistics, 1996–2021.

Year	Tons mined (ore+waste)			Tons Milled (ore)			Tons Placed on Heap Leach <sup>b</sup>	Ounces Gold Produced	Employees
	Fort Knox	True North <sup>a</sup>	Total	Fort Knox	True North <sup>a</sup>	Total			
1996	16,684,000	0	16,684,000	769,700	0	769,700		16,085	243
1997	32,380,000	0	32,380,000	12,163,151	0	12,163,151		366,223	249
1998	33,294,000	0	33,294,000	13,741,610	0	13,741,610		365,320	245
1999	30,350,000	0	30,350,000	13,819,010	0	13,819,010		351,120	253
2000	35,600,000	0	35,600,000	15,000,000	0	15,000,000		362,929	253
2001	25,957,900	8,448,400	34,406,300	13,282,614	2,377,386	15,660,000		411,220	360
2002	24,583,500	11,461,000	36,044,500	11,887,200	3,371,800	15,259,000		410,519	360
2003	30,597,940	12,707,100	43,305,040	11,473,000	3,611,682	15,084,682		391,831	316
2004	44,187,000	3,763,000	47,950,000	12,917,966	1,675,854	14,593,820		338,334	427
2005	63,248,000	0	63,248,000	14,384,842	0	14,384,842		329,320	411
2006	51,070,000	0	51,070,000	14,839,297	0	14,839,297		333,383	406
2007	45,940,000	0	45,940,000	14,021,400	0	14,021,400		338,459	399
2008	46,300,000	0	46,300,000	15,110,000	0	15,110,000		329,105	449
2009	27,585,000	0	27,585,000	17,884,000	0	17,884,000		263,260	500
2010	42,400,000	0	42,400,000	14,560,000	0	14,560,000		349,729	525
2011	34,550,000	0	34,550,000	14,880,000	0	14,880,000		289,794	522
2012	63,120,000	0	63,120,000	14,550,000	0	14,550,000		359,948	565
2013	63,280,000	0	63,280,000	13,960,000	0	13,960,000		428,822	629
2014	49,240,000	0	49,240,000	14,920,000	0	14,920,000	28,500,000	387,285	649
2015	60,860,000	0	60,860,000	14,820,000	0	14,820,000	27,700,000	401,553	657
2016	65,240,000	0	65,240,000	14,570,000	0	14,570,000	32,124,000	409,845	660
2017	60,450,000	0	60,450,000	13,744,703	0	13,744,703	22,340,517	381,115	627
2018	71,850,000	0	71,850,000	12,996,250	0	12,996,250	17,975,390	255,569	630
2019 <sup>c</sup>	27,962,298	0	27,962,298	8,905,562	0	8,905,562	20,373,996	200,263	655
2020 <sup>c</sup>	31,491,894	0	31,491,894	10,090,546	0	10,090,546	25,347,618	237,925	620
2021 <sup>c</sup>	38,527,022	0	38,527,022	8,881,018	0	8,881,018	32,883,680	264,283	650
<b>Total</b>	<b>1,116,748,554</b>	<b>36,379,500</b>	<b>1,153,128,054</b>	<b>338,171,869</b>	<b>11,036,722</b>	<b>349,208,591</b>	<b>309,956,009</b>	<b>8,573,239</b>	

<sup>a</sup>True North Mine started production in 2001 and suspended production in 2004.

<sup>b</sup>Walter Creek heap leach facility started production in 2009. Barnes Creek

heap leach facility started production in 2020.

<sup>c</sup>Company reported ounces of gold produced in gold-equivalent ounces.

supply reservoir was partially drained so repair and maintenance activities could be conducted. The company met or exceeded all site level targets for permitting, water management, and closure planning, and maintained its record of zero tailings breaches for the 29th consecutive year.

## Gil Mine

Kinross Gold Corp. opened the Gil Mine on September 23, 2021, which became the sixth large-scale metal mine in Alaska. The Gil Mine is about eight miles east of the Fort Knox Mine complex. Gold mineralization at the Gil-Sourdough prospects was discovered in the 1980s, and Kinross acquired full ownership of the deposit in 2011. The Gil deposit consists of approximately 11 million tons of gold ore averaging 0.018 ounces of gold per ton, for a total of 193,000 gold ounces. It is part of the larger Gil-Sourdough resource area hosting 32.5 million tons of resource grading 0.016 ounces of gold per ton, for a resource of 533,000 ounces of gold.

The initial non-sustaining capital costs were approximately \$30 million, with a sustaining capital expenditure of approximately \$10 million. Kinross constructed 8.75 miles of haul road from the Fort Knox Mine to the Gil Mine and completed infrastructure to support mining from the main Gil pit.

The Gil Mine is expected to add 80–100 jobs while producing approximately 160,000 ounces of gold equivalent over a two-year mine life at an estimated cost of sales of approximately \$920 per gold equivalent ounce. The ore from the Gil deposit will be transported twelve miles east to the mill at the Fort Knox Mine for processing, using existing roads on the Fort Knox property. The mill recovery rate for Gil ore was approximately 83 percent.

**Photo 13.** Opening of the Gil Mine eight miles east of Fort Knox Mine. Photo: Brenna Schaake, Kinross Gold Corp.

Alaska Aggregate Products was contracted to do the mining at the Gil Mine. Gold production and costs associated with producing gold from the Gil Mine are reported as part of the Fort Knox Mine production statistics. Ore production commenced in the main Gil pit during October 2021. The mining contractor and Kinross mined 0.71 million tons from the main Gil pit, which consisted of 0.16 million tons of mill ore and 0.55 million tons of waste. Mining methods at the Gil Mine are similar to those at the Fort Knox Mine, but smaller loading and haulage equipment is used. Loading, haulage, and mine support equipment is owned and operated by the mining contractor. Fort Knox Mine personnel performed drilling and blasting and provided technical services support (e.g., mine planning, surveying, and ore control).

## Pogo Mine

Northern Star Resources' Pogo Mine poured its four-millionth ounce of gold in 2020. The mine in Interior Alaska consists of a set of structurally controlled, gold-bearing quartz veins that are mined underground through a combination of long-hole open stoping and cut-and-fill mining methods. The on-site mill employs gravity, flotation, and cyanide-leaching processes to recover the gold. The mine employed approximately 500 full-time staff in 2021.

Development continued throughout the year, and the ongoing focus for 2021 was accelerated decline advance to enable access to additional stoping horizons and establishing diamond drill platforms to further grow the Pogo Mine



resource. Mining crews set a new monthly development record by averaging more than 4,900 feet of horizontal advance. A quarterly record for total diamond drill footage was also achieved. The processing plant was upgraded, including tie-in and commissioning works, to improve throughput capacity from 1.1 million tons per year to 1.4 million tons per year. Other major works were also completed, including replacing the primary conveyor belt that transports ore from underground to the processing plant.

COVID-19 continued to impact the productivity of the operation, and management protocols and hygiene precautions remained in place as Pogo Mine continued to operate through the pandemic. The availability of vaccines and significantly lower COVID-19 rates in Alaska reduced operational disruptions by the end of 2021.

Northern Star continued to increase total resources during 2021, finishing the year with a

20 percent increase to a probable reserve of 7.26 million tons grading 0.248 ounces of gold per ton, for a total of 1.8 million ounces of gold. The combined indicated and inferred resources at the Pogo Mine are 24.6 million tons, grading 0.298 ounce of gold per ton, at a total of 7.3 million contained ounces of gold. This is the largest resource in the property's history (app. D).

Northern Star recovered 188,316 ounces of gold and sold 188,406 ounces of gold, respectively, from the Pogo Mine at an all-in sustaining cost of \$1,613.55 per ounce during 2021. Ore mined during the year was sourced from the Liese, South Pogo, and Fun Zone areas, and had an average mined grade of 0.226 ounces of gold per ton and an average head grade of 0.20 ounces of gold per ton. The operation mined and milled 948,630 and 991,928 tons of ore, respectively (table 21). In June 2021, the mine set a milestone record by processing 101,000 tons

**Table 21.** Pogo Mine production statistics, 2006–2021.

Year	Tons Ore Mined	Tons Ore Milled	Ounces of Gold Recovered	Recovery (%)	Head Grade Gold (oz/ton)	Employees <sup>a</sup>
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 <sup>b</sup>	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 <sup>c</sup>	1,531,890	880,075	227,901	-	-	540
2019	875,298	902,373	154,589	-	-	650
2020	914,775	907,585	205,878	89.7	0.25	660
2021	948,630	991,928	188,316	86.0	0.20	507
<b>Total</b>	<b>14,922,701</b>	<b>12,995,371</b>	<b>4,415,078</b>			

<sup>a</sup>Includes contract employees, if known.

<sup>b</sup>Silver production of 32,000 ounces was reported in 2013.

<sup>c</sup>Values are underreported due to the change in ownership to Northern Star

Resources in 2018.

--- = Not reported

of ore. Average gold recovery during 2021 was approximately 86 percent. The Pogo Mine was ranked 13th in the U.S. by gold output among gold producing operations.

## Usibelli Coal Mine

Usibelli Coal Mine Inc. is a local, family-owned coal mining company that has operated in the Healy area since 1943. The company mines subbituminous coal from the Miocene Suntrana Formation, mainly from leases on state land 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 10 million tons of coal slated for production. The Two Bull Ridge resource has 3.5–5 cubic yards of overburden for each ton of coal, which is contained in multiple seams. Number 3 seam averages 18 feet thick, Number 4 seam is up to 32 feet thick, and Number 6 seam averages 21 feet thick. Gold Run Pass is nearing completion of its mining life, with four of five reclamation stages complete. The Jumbo Dome mine region contains approximately 250 million tons of coal, of which about 80 million tons have been permitted. Number 4 seam averages 40 feet thick with 25–75 feet of overburden above it, and Number 3 seam averages 30 feet thick with 35 feet of overburden between it and Number 4 seam. Stripping ratios are 0.5 cubic yards of overburden per one ton of coal. Poker Flats, now fully reclaimed, produced about 27 million tons of coal beginning in the 1970s.

In 2021, Usibelli produced 1,042,288 tons of coal from its Two Bull Ridge and Jumbo Dome mine sites (fig. 10, table 15). The majority of Usibelli's coal is used for in-state electrical power generation and cogeneration of electricity and heat at Interior Alaska coal-fired power plants, which are a backbone of energy generation in Interior Alaska. In 2020, all coal-fired plants accounted for 50 percent of electricity generation in the region, followed by naphtha (26 percent), and diesel (12 percent) fuel sources. In 2020, fuel costs averaged \$0.06 per kilowatt hour (kWh) at Golden Valley

Electric Association's coal-fired plants, compared to \$0.15/kWh for diesel. The University of Alaska Fairbanks commissioned a new boiler and 17-megawatt turbine generator in February 2020.

Usibelli contracted with McKinley Research Group (formerly McDowell Group) to profile the role of coal in Interior Alaska's energy infrastructure and assess the economic impact of coal in the region. Coal is Interior Alaska's lowest-cost source of energy. Further, as a reliable and low-cost source of energy, coal supports stable consumer prices relative to heating oil, naphtha, or natural gas. Interior Alaska has the advantage of access to high-quality, ultra-low sulfur coal, and improvements in coal technology now offer more efficient, cost-effective ways to use the resource.

Before it began mining coal in the Poker Flats area nearly 40 years ago, Usibelli agreed to restore the land to near-pre-mining conditions and backed its promise with a bond worth about \$2.5 million. In 2021, the DNR declared that Usibelli kept its promise by completing the last of a rigorous reclamation process in the Poker Flats area. Usibelli will receive back about \$411,000 of the remaining portion of its reclamation bond for the land that was reclaimed.

Coal from the Usibelli Coal Mine accounted for 26 percent of the total freight tonnage on the Alaska Railroad in 2021. In 2020, the mine spent \$28.4 million with more than 285 Alaska vendors to purchase goods and services.

Usibelli Coal Mine employed an average 102 workers, all Alaska residents, in 2021, with roughly \$13 million in total payroll. Employment was stable over the year, ranging from a May peak of 105 to a February low of 99. The mine is Healy's largest year-round employer, and approximately 85 percent of its positions are based in Healy, with remaining jobs at offices in Fairbanks and Palmer.

## Kensington Mine

The Kensington Mine is 45 miles north-northwest of Juneau, and is 100 percent owned by Coeur Alaska, Inc., a subsidiary of Coeur Mining, Inc. It lies within the Berners Bay area at



the northern-most edge of the Juneau Gold Belt. Gold-bearing mesothermal, quartz, carbonate, and pyrite vein swarms, and discrete quartz-pyrite veins are hosted in the Cretaceous-aged Jualin diorite. Most of the gold is contained in calaverite (AuTe<sub>2</sub>) that occurs in association with native gold as inclusions in and interstitial to pyrite grains and in microfractures in pyrite. The underground Kensington Mine consists of at least three major, structurally controlled, orogenic-gold vein systems (Kensington Main, Jualin, and Raven), which are being mined by long-hole stoping and drift-and-fill methods, with gold recovered as a concentrate using flotation processes. Kensington Mine reserves totaled 261,000 ounces of gold as of December 31, 2021, and additional resources totaling 1.44 million ounces of gold are tabulated in appendix D.

Kensington employed 392 employees, not including contractors. In the second year of the COVID-19 pandemic, Coeur continued protocols to minimize the impact to its workforce and operations. Coeur Mining received the 2021 Mine Safety and Health Technology Innovations Award for the implementation of a comprehensive pandemic response plan to mitigate the spread of COVID-19 at its worksites.

In 2021, 272,393 tons of development rock were mined, with 133,866 tons brought to the surface, and 152,622 tons placed underground as backfill. In addition, 329,363 tons of tailings were transported to the tailings treatment facility, and 315,690 tons of tailings were conveyed to the underground paste plant for disposal in the underground stopes.

Production and exploration core drilling totaled 187,029 feet. The drilling was completed by a contracted drilling company using NQ and HQ core drill tooling.

The mill processed 667,560 tons of material at an average grade of 0.19 ounces of gold per ton with an average 93.2 percent recovery rate (table 22). Full-year production was 121,140 ounces of gold. This three percent decline from 2020 was due to mining lower grade ore and lower mill throughput. Production from the higher-grade Jualin ore body accounted for approximately 18 percent of Kensington's total production. The Kensington Mine was ranked 17th among gold-producing operations in the U.S. in 2021.

Metal sales from the Kensington Mine totaled \$215.0 million. Costs applicable to sales for the year increased to \$1,086 per ounce of

Year	Ore (tons milled)	Ore Grade Gold (oz/ton)	Gold Recovery (%)	Gold Produced (oz)
2010 <sup>a</sup>	174,028	0.28	89.9	43,143
2011	415,340	0.23	92.7	88,420
2012	394,780	0.22	95.6	82,125
2013	553,717	0.21	96.6	114,821
2014	635,960	0.20	94.1	117,823
2015	659,786	0.20	94.9	128,865
2016	620,209	0.21	94.7	124,331
2017	668,727	0.18	93.5	115,094
2018	641,058	0.18	92.3	113,778
2019	658,378	0.21	91.0	127,914
2020	675,731	0.20	93.0	124,867
2021	667,560	0.19	93.2	121,140
<b>Total</b>	<b>6,765,274</b>			<b>1,302,321</b>

**Table 22.** Kensington Mine production statistics, 2010–2021.

<sup>a</sup>Production started July 3, 2010.

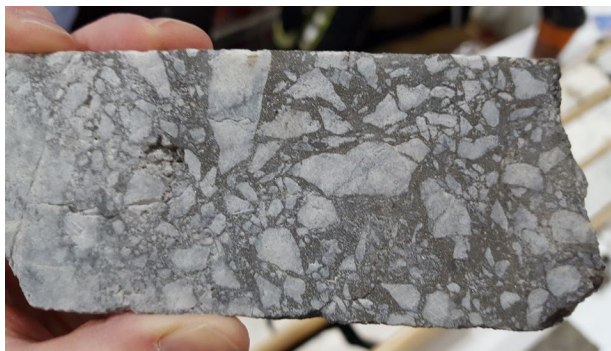
gold compared to \$975 in 2020 due to lower production and higher employee-related, maintenance and consumable costs. Total sustaining and development capital expenditures were \$27.5 million, with an increase from 2020 due to higher infill drilling footage and increase underground development.

The U.S. Forest Service continued work on a Supplemental Environmental Impact Statement (SEIS) evaluating Coeur Alaska's proposed Plan of Operations Amendment 1 to increase tailings and waste-rock storage capacity, with the anticipated extension of Kensington's mine life by 10 years to 2033. The draft SEIS was released in October 2020 and underwent a public comment period ending in early January 2021. The U.S. Forest Service released the final SEIS and draft ROD on July 9, 2021. The final ROD is expected in early 2022.

## Greens Creek Mine

The Greens Creek Mine, owned and operated by Hecla Greens Creek Mining Company, is a polymetallic, silver-rich VMS deposit located about 20 miles southwest of Juneau. The 24-square-mile property lies within the Admiralty Island National Monument. The underground mine has been in production since 1989 and is accessed by a ramp from surface. Mining is primarily by cut-and-fill and longhole stoping methods. The 2,300 ton-per-day mill includes a SAG and ball mill grinding circuit, a gravity circuit to recover free gold and electrum, and a flotation circuit that produces three types of concentrates. Other related infrastructure includes a tailings storage area, a ship-loading facility, camp facilities, and a ferry dock. Hecla employed 450 workers at the Greens Creek Mine in 2021.

The Greens Creek Mine is the U.S.'s leading producer of silver and the third largest producer of zinc. The mine is the fifth largest in the U.S. in terms of lead output and ranked 23rd in terms of gold production. The mine ranks in the world's top ten largest silver producers, and it is one of the largest and lowest-cost primary silver mines in the world.



**Photo 14.** Gold-bearing ore in the Elmira Breccia associated with the Elmira Vein, Kensington Mine. Photo: Coeur Alaska Inc.

Measures to limit the spread of COVID-19 affected mine operations and employees, but production remained at levels comparable to prior years. COVID-19 mitigation measures and high vaccination rates limited negative impacts on the Greens Creek Mine property.

The Greens Creek Mine facilities processed 841,967 tons of ore in 2021, yielding 9.24 million ounces of silver, 46,088 ounces of gold, 53,648 tons of zinc, and 19,873 tons of lead (table 23). Ore grades milled were 13.51 ounces of silver per ton, 0.08 ounces of gold per ton, 2.87 percent lead, and 7.11 percent zinc. Production of all metals and ore grades were down from 2020 values largely due to mining easier-to-access, but lower-grade, ore, and because of manpower challenges.

Hecla's 2021 sales totaled \$384.8 million, yielding \$171.7 million in gross profit—an increase of five percent over 2020—after production and sales costs, depreciation, depletion, and amortization. This was due to increased prices for all metals produced, as well as favorable changes in concentrate smelter terms. The positive factors were partially offset by lower metal sales volume primarily due to lower ore grades. The total production cost per ton was \$177.30, a one percent decrease from 2020, reflecting decreased labor and maintenance costs as well as COVID-19-related costs. The all-in sustaining cost of production, after byproduct credits, was \$3.19 per ounce of silver. Greens Creek Mine spent \$23.9 million on capital additions, including

underground access and capitalized resource drilling, compared to \$19.69 million in 2020.

The mill at the Greens Creek Mine generates approximately 1,800 dry short tons (DST) of filter-pressed tailings per day, or approximately 650,000 DST of tailings annually. Tailings are

dewatered in a filter press; about 50 percent is mixed with cement and hauled underground for disposal in mined-out areas as backfill. The remaining amount is transported in covered trailers from the mill and placed, using dry-stacking techniques, in the surface tailings disposal facility

**Table 23.** Greens Creek Mine production statistics, 1989–2021.

Year	Tons Milled	Tons Concentrate	Metal Produced					Employees
			Tons Zinc	Tons Lead	Tons Copper <sup>a</sup>	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 <sup>b</sup>	77,780	–	9,500	3,515	–	7,350	1,721,878	217
1994 <sup>c</sup>	–	–	–	–	–	–	–	–
1995 <sup>c</sup>	–	–	–	–	–	–	–	–
1996 <sup>b</sup>	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
2006	732,176	–	59,429	20,992	–	62,935	8,865,818	245
2007	732,227	–	62,603	21,029	–	68,006	8,646,825	276
2008	734,910	–	58,224	18,562	–	67,269	7,145,711	336
2009	790,871	–	70,379	22,253	–	67,278	7,459,170	321
2010	800,397	–	74,496	25,336	–	68,838	7,206,973	343
2011	772,069	–	66,050	21,055	–	56,818	6,498,337	364
2012	789,569	–	64,249	21,074	–	55,496	6,394,235	386
2013	805,322	–	57,614	20,114	–	57,457	7,448,347	390
2014	816,213	–	59,810	20,151	–	58,810	7,826,341	415
2015	814,398	–	61,934	21,617	–	60,566	8,452,153	418
2016	815,639	–	57,729	20,596	–	53,912	9,253,543	414
2017	839,589	–	52,547	17,996	–	50,854	8,351,882	423
2018	845,398	–	55,350	18,960	–	51,493	7,953,003	426
2019	846,076	–	56,805	20,112	–	56,625	9,890,125	426
2020	818,408	–	56,814	21,400	–	48,491	10,494,726	442
	841,967	–	53,648	19,873	–	46,088	9,243,222	450
<b>Total</b>	<b>20,327,075</b>	<b>–</b>	<b>1,898,021</b>	<b>612,621</b>	<b>8,593</b>	<b>1,850,217</b>	<b>257,644,492</b>	

<sup>a</sup>No copper credits in 1989–1993 and 2003–2021.

<sup>b</sup>Partial-year production.

<sup>c</sup>No production in 1994 and 1995 due to mine closure.

– = Not reported

near Hawk Inlet. In 2021, the Greens Creek Mine placed 388,912 tons of tailings and 60,948 tons of waste rock at the tailings disposal facility.

Underground definition and exploration drilling during 2021 focused on eight of the nine known mineralized zones on the property. Mine planning for 2022 included approximately 80,000 feet of definition drilling in five zones and approximately 20,000 feet of exploration drilling in six zones. The mine plan at the end of 2021 included reserves and resources sufficient for approximately 13 years of production (app. D).

### Dawson Mine

The Dawson Mine, operated by Sundance Mining Group, LLC, is located on Prince of Wales Island, about 3.5 miles from the Hollis Ferry Terminal. The mine exploits a medium-sized, low-sulfide, high-grade, free-milling gold-silver deposit. Veins are hosted by shale and siltstone of the Descon Formation, which locally contains sills and dikes. The quartz-vein system dips 28 degrees, and ore minerals include galena, chalcopryrite, sphalerite, tellurides, and free gold. Ore occurs within a linear north-trending zone, which, from south to north, includes the past-producing Harris River and

Dawson mines, Upper Crackerjack workings, and Puyallup Mine.

The mine's work schedule is three weeks on and two weeks off for mining crews and two weeks on and one week off for mill crews. Typical room and pillar mining is conducted with-up dip-jackleg drilling and slusher mining equipment, with rubber tired horizontal exploration and development entries and haulage-ways. Gold production was 12,821 ounces from 19,855 dry tons of ore in 2021. The mine had 54 full-time employees in 2021, 35 of the 47 Alaska residents lived on Prince of Wales Island. There were no lost-time accidents and no COVID-19 cases.

The Dawson Mine's mill circuit uses gravity-only separation with no chemicals. The 150-ton-per-day mill runs 24 hours per day following a two-weeks on, one-week off schedule. The average mill feed grade in 2021 was 0.720 ounces of gold per ton, and the recovery average was 86.5 percent. Mass pull of concentrate averaged 4.3 percent. An average of 75 tons of concentrate was shipped to Germany monthly. Dore' to concentrate ratio was approximately 30/70. The mine shipped 926 dry tons of concentrate, averaging 10.650 ounces of gold per ton, to Japan and Germany.



**Photo 15.** Ore awaiting haulage from the underground Dawson Mine. Photo: Sundance Mining Group LLC.

## Calder Mine

The Calder Mine is located on the northern end of Prince of Wales Island, 88 miles west of Ketchikan. It was developed as a dimensional marble quarry in the early twentieth century, but although the marble is bright white, it did not meet specifications for monuments or architecture, and the quarry closed after several years of operation. At the end of the century, the quarry was restarted by Sealaska Corporation to supply calcium carbonate to various industries. In 2011, Columbia River Carbonates (CRC) purchased the property and began development and renovation of existing infrastructure.

The Calder Mine site includes an open-pit calcium carbonate mine, loading/barge area, fueling station, shop area, and camp site. Additional site improvements include gravel access roadways, diesel power generators, and a potable water storage/treatment system.

Calder Mine has a proven ore reserve that is expected to last at least 75 years, with resource-expansion potential. The ore body is classified as being uniquely pure and yields uniform, bright white stone. The mine operates on a seasonal basis; barges carry the stone to CRC's plant in Woodland, Washington, where it is turned into a range of wet and dry calcium carbonate products for use in the paper, glass, plastics, paint,

construction, agriculture, and other industries. Production data for 2021 was not reported.

## Nixon Fork Mine

The Nixon Fork underground mine is a copper–gold skarn deposit located 32 miles northeast of McGrath and operated by Mystery Creek Resources, Inc., a wholly owned subsidiary of Titan Resources, Ltd. The Nixon Fork Mine is an underground cut-and-fill, shrinkage, and sub-level open stoping operation that uses gravity and flotation processes to recover copper concentrate, and carbon-in-leach to recover gold. The property includes an 85-person camp. The last reported resources are approximately 145,000 tons, containing 136,000 ounces of gold.

Mystery Creek submitted a revised water treatment system description and cost estimate to the BLM on January 15, 2021, who provided the revised plan to Alaska DEC on January 19 for review and comment. The BLM scheduled meetings with Mystery Creek and adjacent landowners for February 11, 2021, to discuss on-going negotiations regarding the legacy stamp mill tailings.

Ownership of Mystery Creek Resources Inc. was transferred from Titan Resources Ltd. to Caribou Minerals Pty Ltd., an Australian private company headquartered in Perth, Australia, on August 13, 2021.

# DRILLING

Twenty-four companies publicly reported drilling programs in Alaska across all sectors in 2021 (table 24). Total drilling, including both publicly reported and confidential drilling footages, increased to 2,252,629 feet (table 25). Development drilling totaled 570,489 feet, and production drilling totaled 797,900 feet. Large

increases in pre-production drilling are likely due mainly to changes in reporting methods but may also include increased activity.

Thirty-three individual projects reported 884,241 feet of exploration drilling in 2021, an increase from 20 projects in 2020, as well a 32 percent increase in footage drilled. Reverse circulation (rotary) drilling totaled 94,655 feet in 2021. This is a 70 percent increase from the 2020 reported hardrock rotary footage total.

Drilling footage was primarily compiled from questionnaires, public company reports, and online information, and represents a minimum amount for 2021. Production drilling is under-reported, and placer exploration drilling in 2021 was not compiled. Drilling for all phases of coal mining was not reported. Blast-hole drilling during production at Alaska’s large lode mines was not tracked.

**Table 24.** Companies publicly reporting significant drilling programs in Alaska in 2021.

<b>Ambler Metals LLC</b>	<b>Heliostar Metals Ltd.</b>
<b>Avidian Gold</b>	<b>HighGold Mining Inc.</b>
<b>Blackwolf Copper and Gold Ltd.</b>	<b>Kenorlands Minerals Ltd.</b>
<b>Coeur Alaska Inc.</b>	<b>Kinross Gold Corp.</b>
<b>Constantine Metal Resources Ltd. (with Dowa Metals &amp; Mining Alaska Ltd.)</b>	<b>Northern Star Resources Ltd.</b>
<b>Donlin Gold LLC</b>	<b>Nova Minerals Ltd.</b>
<b>Freegold Ventures Ltd.</b>	<b>Peak Gold LLC</b>
<b>Graphite One Inc.</b>	<b>PolarX Ltd.</b>
<b>Great American Minerals Exploration Inc.</b>	<b>Resolution Minerals Ltd.</b>
<b>Grand Portage Resources Ltd.</b>	<b>Teck Alaska Inc.</b>
<b>Hecla Mining Company</b>	<b>Tectonic Metals Inc.</b>
	<b>Western Alaska Copper &amp; Gold Inc.</b>
	<b>White Rock Minerals Ltd.</b>



**Photo 16.** Exploration drilling on the Pogo Mine property. Photo: Northern Star Resources Ltd..

**Table 25.** Drilling footage reported or estimated in Alaska, 1982–2021.

Year	Placer Exploration	Placer Thawing	Total Placer	Total Coal	Hardrock Core <sup>a</sup>	Hardrock Rotary <sup>a</sup>	Total Hardrock	Total Feet Drilled
1982	30,000	94,000	124,000	80,000	-	-	200,000	404,000
1983	23,000	30,000	53,000	12,000	-	-	180,500	245,500
1984	31,000	98,000	129,000	25,700	-	-	176,000	330,700
1985	46,000	34,000	80,000	8,700	-	-	131,700	220,400
1986	32,400	227,000	259,400	28,800	-	-	50,200	338,400
1987	50,250	130,000	180,250	19,900	95,600	19,500	115,100	315,250
1988	152,000	300,000	452,000	26,150	223,630	130,230	353,860	832,010
1989	97,250	210,000	307,250	38,670	242,440	89,790	332,230	678,150
1990	78,930	105,000	183,930	18,195	648,600	112,355	760,955	963,080
1991	51,247	130,000	181,247	16,894	205,805	110,850	316,655	514,796
1992	6,740	65,000	71,740	12,875	211,812	148,022	359,834	444,449
1993	25,216	-	25,216	-	124,325	127,990	252,315	277,531
1994	21,000	-	21,000	8,168	347,018	91,692	438,710	467,878
1995	27,570	-	27,570	-	363,690	51,795	415,485	443,055
1996	61,780	-	61,780	8,500	524,330	134,527	658,857	729,137
1997	38,980	-	38,980	13,998	523,676	180,834	704,510	757,488
1998	33,250	-	33,250	2,300	505,408	45,670	551,078	586,628
1999	6,727	-	6,727	-	369,863	78,934	448,797	455,524
2000	15,480	-	15,480	-	418,630	127,638	546,268	561,748
2001	1,100	-	1,100	36,151	240,318	75,750	316,068	353,319
2002	1,250	-	1,250	-	385,290	103,612	488,902	490,152
2003	10,108	-	10,108	2,000	270,456	100,178	370,634	382,742
2004	107,526	-	107,526	-	415,628	36,024	451,652	559,178
2005	3,360	-	3,360	-	592,497	41,780	634,277	637,637
2006	8,759	-	8,759	7,500	765,363	54,173	819,536	835,795
2007	19,575	-	19,575	50,539	830,478	268,112	1,098,590	1,168,704
2008	1,216	-	1,216	26,869	874,634	250,278	1,124,912	1,152,997
2009	1,244	-	1,244	W	403,275	260,059	663,334	664,578
2010	10,427	-	10,427	11,601	688,911	216,768	905,679	927,707
2011	3,150	-	3,150	W	883,272	175,181	1,058,453	1,061,603
2012	13,282	-	13,282	7,704	1,082,439	14,182	1,096,621	1,117,607
2013	17,986	-	17,986	W	933,194	17,800	950,994	968,980
2014	7,227	-	7,227	W	487,106	9,736	496,842	504,069
2015	-	-	-	W	923,324	12,795	937,769	937,769
2016	-	-	-	-	644,512	W	644,512	644,512
2017	-	-	-	W	1,016,731	W	1,016,731	1,016,731
2018	-	-	-	W	1,039,089	W	1,039,089	1,039,089
2019	-	-	-	W	812,933	35,267	848,200	848,200
2020 <sup>b</sup>	-	-	-	-	1,917,082	55,553	1,972,635	1,972,635
2021 <sup>b</sup>	-	-	-	-	2,157,974	94,655	2,252,629	2,252,629

<sup>a</sup>Core and rotary drilling not differentiated prior to 1987.<sup>b</sup>Changes in reporting of pre-production drilling at some sites explain the increase from 2019.

- = Not reported

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

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**Photo 17.** Drill rig at Upper Difficult Creek prospect. Photo: HighGold Mining Inc.



## APPENDIX A

### Resources Related to the Minerals Industry in Alaska



#### DEPARTMENT OF NATURAL RESOURCES

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

#### Division of Mining, Land & Water

- Mining Applications and Forms – [dnr.alaska.gov/mlw/forms/](http://dnr.alaska.gov/mlw/forms/)
- Fact Sheets – [dnr.alaska.gov/mlw/factsheets/](http://dnr.alaska.gov/mlw/factsheets/)
- Annual Placer Mining Application (APMA) – [dnr.alaska.gov/mlw/mining/apma/](http://dnr.alaska.gov/mlw/mining/apma/)
- Annual Rental – [dnr.alaska.gov/mlw/cdn/pdf/factsheets/annual-rent.pdf](http://dnr.alaska.gov/mlw/cdn/pdf/factsheets/annual-rent.pdf)
- Leasing State Land – [dnr.alaska.gov/mlw/cdn/pdf/factsheets/leasing-state-land.pdf](http://dnr.alaska.gov/mlw/cdn/pdf/factsheets/leasing-state-land.pdf)
- Land Lease & Contract Payment Information – [dnr.alaska.gov/mlw/cdn/pdf/factsheets/land-lease-and-contract-payment-information.pdf](http://dnr.alaska.gov/mlw/cdn/pdf/factsheets/land-lease-and-contract-payment-information.pdf)
- Production Royalty – [dnr.alaska.gov/mlw/cdn/pdf/factsheets/production-royalty.pdf](http://dnr.alaska.gov/mlw/cdn/pdf/factsheets/production-royalty.pdf)
- DNR Production Royalty Form – [dnr.alaska.gov/mlw/cdn/pdf/forms/Production-Royalty-Form-2021.pdf](http://dnr.alaska.gov/mlw/cdn/pdf/forms/Production-Royalty-Form-2021.pdf)
- Exploration Incentive Credit Program – [dnr.alaska.gov/mlw/cdn/pdf/factsheets/exploration-incentive-credit-program.pdf](http://dnr.alaska.gov/mlw/cdn/pdf/factsheets/exploration-incentive-credit-program.pdf)



#### Division of Geological & Geophysical Surveys

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

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

- MDIRA Portal Home Page – [akgeology.info](http://akgeology.info)
- Alaska Mining Claims Mapper – [mapper.dnr.alaska.gov](http://mapper.dnr.alaska.gov)
- Land Records Web Application – [dnr.alaska.gov/landrecords](http://dnr.alaska.gov/landrecords)
- State Recorder's Office Search – [dnr.alaska.gov/ssd/recoff/searchRO.cfm](http://dnr.alaska.gov/ssd/recoff/searchRO.cfm)
- Alaska Resource Data File – [usgs.gov/centers/alaska-science-center/science/alaska-resource-data-file](http://usgs.gov/centers/alaska-science-center/science/alaska-resource-data-file)
- USGS Alaska Geochemical Database, Version 3.0 (NURE, RASS, PLUTO...) – [pubs.er.usgs.gov/publication/ds1117](http://pubs.er.usgs.gov/publication/ds1117)



#### DEPARTMENT OF COMMERCE, COMMUNITY, AND ECONOMIC DEVELOPMENT

- Community and Regional Information – [www.commerce.alaska.gov/web/dkra/ResearchAnalysis](http://www.commerce.alaska.gov/web/dkra/ResearchAnalysis)
- Alaska Industrial Development and Export Authority (AIDEA) – [www.aidea.org](http://www.aidea.org)
- AIDEA Supports Mining – [www.aidea.org/Programs/ProjectDevelopment/35YearsofMiningSupport.aspx](http://www.aidea.org/Programs/ProjectDevelopment/35YearsofMiningSupport.aspx)



#### DEPARTMENT OF REVENUE

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

## APPENDIX B

### Primary metals production in Alaska, 1880–2021<sup>a</sup>

Year	Gold <sup>b</sup>		Silver		Mercury		Antimony		Tin	
	(oz)	(m\$)	(oz)	(t\$)	(flask <sup>c</sup> )	(t\$)	(lb)	(t\$)	(lb)	(t\$)
1880–99	1,153,889	\$23.9	496,101	\$329.0	-	-	-	-	-	-
1900–09	6,673,173	137.9	1,324,580	779.5	-	-	-	-	304,000	\$112.2
1910–19	7,209,094	149.0	7,058,235	5,107.5	-	-	2,760,000	W	1,640,000	805.9
1920–29	3,373,336	69.8	6,407,375	5,160.8	117	\$7.6	W	W	317,800	163.9
1930–39	5,345,205	150.8	3,250,173	1,889.8	31	2.3	1,616,000	\$228.3	1,024,400	502.1
1940–49	3,137,447	109.8	794,842	577.0	3,094	724.3	2,062,080	311.1	319,200	230.3
1950–59	2,297,827	80.6	321,669	292.9	18,185	4,370.0	2,663,520	3,697.6	1,144,000	1,310.5
1960–69	751,870	26.6	59,300	70.7	13,996	3,098.0	228,800	267.8	-	-
1970–79	324,906	55.8	54,700	250.5	4,040	1,694.0	1,473,000	1,714.0	166,000	949.0
1980	75,000	32.0	7,500	111.0	-	-	-	-	120,000	984.0
1981	134,200	55.2	13,420	111.3	W	W	-	-	106,000	700.0
1982	175,000	69.9	22,000	198.0	-	-	-	-	198,000	1,365.0
1983	169,000	67.6	33,200	332.0	-	-	22,400	45.0	215,000	1,100.0
1984	175,000	62.1	20,000	159.0	5	1.5	135,000	225.8	225,000	400.0
1985	190,000	61.2	28,500	171.0	27	10.0	65,000	98.0	300,000	650.0
1986	160,000	60.8	24,000	134.4	12	2.8	45,000	67.5	340,000	890.0
1987	229,707	104.5	54,300	391.0	-	-	-	-	288,000	460.0
1988	265,500	112.8	47,790	282.0	W	W	-	-	300,000	950.0
1989	284,617	108.7	5,211,591	27,300.0	-	-	-	-	194,000	672.0
1990	231,700	89.2	10,135,000	50,675.0	-	-	-	-	57,000	200.0
1991	243,900	88.3	9,076,854	39,110.0	-	-	-	-	6,800	22.1
1992	262,530	88.5	9,115,755	34,913.0	-	-	-	-	1,500	5.9
1993	191,265	68.6	5,658,958	24,333.0	-	-	-	-	21,000	50.6
1994	182,100	70.3	1,968,000	10,391.0	-	-	-	-	-	-
1995	141,882	56.0	1,225,730	6,655.0	-	-	-	-	-	-
1996	161,565	62.6	3,676,000	19,078.0	-	-	-	-	-	-
1997	590,516	207.3	14,401,165	70,710.0	-	-	-	-	-	-
1998	594,191	174.6	14,856,000	82,154.0	-	-	-	-	-	-
1999	517,890	144.3	16,467,000	85,628.0	-	-	-	-	-	-
2000	551,982	154.1	18,226,615	90,404.0	-	-	-	-	-	-
2001	550,644	149.3	16,798,000	73,408.0	-	-	-	-	-	-
2002	562,094	174.3	17,858,183	82,326.0	-	-	-	-	-	-
2003	528,191	191.9	18,589,100	95,300.0	-	-	-	-	-	-
2004	456,508	192.3	16,947,270	113,056.9	-	-	-	-	-	-
2005	427,031	189.9	11,670,000	85,382.0	-	-	-	-	-	-
2006	570,129	344.1	16,489,394	190,415.9	-	-	-	-	-	-
2007	726,933	511.1	20,203,985	270,402.1	-	-	-	-	-	-
2008	800,752	698.2	14,643,735	219,496.4	-	-	-	-	-	-
2009	780,657	759.1	15,617,436	229,159.3	-	-	-	-	-	-
2010	914,462	1,119.8	13,991,297	282,523.5	-	-	-	-	-	-
2011	848,945	1,334.1	11,683,967	410,340.9	-	-	-	-	-	-
2012	921,240	1,537.5	12,313,877	383,573.6	-	-	-	-	-	-
2013	1,022,987	1,551.9	13,453,367	320,121.0	-	-	-	-	-	-
2014	948,547	1,201.2	15,388,901	304,392.5	-	-	-	-	-	-
2015	941,394	1,013.9	15,147,249	237,508.9	-	-	-	-	-	-
2016	909,242	1,119.3	16,621,035	246,109.8	-	-	-	-	-	-
2017	859,631	1,064.0	16,085,142	274,163.2	-	-	-	-	-	-
2018	711,986	888.3	15,116,355	210,826.8	-	-	-	-	-	-
2019	589,080	802.5	17,674,583	258,052.1	-	-	-	-	-	-
2020	651,418	1,105.4	17,997,209	321,364.2	-	-	-	-	-	-
2021	674,693	1,212.6	16,714,807	419,708.8	-	-	-	-	-	-
Other <sup>e</sup>	489,537	-	-	-	1,438	-	-	-	-	-
<b>Total</b>	<b>51,680,394</b>	<b>\$19,903.5</b>	<b>461,041,245</b>	<b>\$5,585,330.4</b>	<b>40,945</b>	<b>\$9,910.5</b>	<b>11,070,800</b>	<b>\$6,655.1</b>	<b>7,287,700</b>	<b>\$12,523.5</b>

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

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

<sup>b</sup>Gold production adjusted to be more consistent with mining district production totals.

<sup>c</sup>76-lb flask.

<sup>d</sup>Crude platinum; total production of refined metal is about 575,000 oz.

<sup>e</sup>Not traceable by year

## APPENDIX B, CONTINUED

### Primary metals production in Alaska, 1880–2021<sup>a</sup>

Year	Lead		Zinc		Platinum <sup>d</sup>		Copper		Chromium	
	(tons)	(t\$)	(tons)	(t\$)	(oz)	(t\$)	(lb)	(m\$)	(tons)	(t\$)
1880–99	250	\$ 17.0	-	-	-	-	-	-	-	-
1900–09	369	32.8	-	-	-	-	29,549,486	\$ 4.8	-	-
1910–19	3,565	470.2	-	-	914	\$116.5	515,253,817	109.9	2,200	W
1920–29	7,961	1,084.1	-	-	5,750	484.9	643,576,929	93.3	-	-
1930–39	10,791	914.3	-	-	102,615	5,427.1	184,522,000	19.5	-	-
1940–49	3,096	405.2	678	\$ 0.5	225,285	12,623.3	433,700	0.2	7,409	\$ 250.9
1950–59	177	38.6	-	-	107,927	9,403.9	106,000	0.1	21,442	1,975.8
1960–69	40	9.9	-	-	111,556	13,618.5	352,000	0.1	-	-
1970–79	20	8.0	-	-	41,604	6,826.0	-	-	8,000	1,200.0
1980	31	29.0	-	-	-	-	-	-	-	-
1981	-	-	-	-	900	200.0	-	-	-	-
1982	-	-	-	-	W	W	-	-	-	-
1983	-	-	-	-	W	W	-	-	-	-
1984	-	-	-	-	W	W	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	W	W	-	-	-	-
1987	-	-	-	-	W	W	-	-	-	-
1988	-	-	-	-	25	13.8	-	-	-	-
1989	9,585	7,700.0	19,843	29,400.0	-	-	-	-	-	-
1990	44,220	30,954.0	181,200	253,680.0	-	-	-	-	-	-
1991	69,591	33,403.7	278,221	278,221.0	15	5.3	-	-	-	-
1992	68,664	31,585.0	274,507	301,957.7	-	-	-	-	-	-
1993	38,221	13,759.6	268,769	236,516.7	3	1.2	-	-	-	-
1994	36,447	25,512.9	329,003	296,102.7	5	2.1	-	-	-	-
1995	58,098	34,428.6	359,950	345,552.0	1	0.4	-	-	-	-
1996	70,086	52,284.0	366,780	361,646.0	2	0.8	780,000	0.8	-	-
1997	88,560	49,593.0	419,097	494,888.0	-	-	3,440,000	3.5	-	-
1998	102,887	49,386.0	549,348	505,400.0	-	-	3,800,000	2.9	-	-
1999	125,208	57,596.0	643,642	630,769.0	-	-	4,200,000	3.0	-	-
2000	123,224	51,754.0	669,112	682,494.0	-	-	2,800,000	2.3	-	-
2001	127,385	56,049.0	634,883	507,907.0	-	-	2,800,000	2.0	-	-
2002	146,462	61,514.0	718,103	502,674.0	-	-	3,200,000	2.3	-	-
2003	162,479	64,279.0	714,769	536,348.0	-	-	-	-	-	-
2004	150,796	120,636.8	680,015	651,432.2	-	-	-	-	-	-
2005	131,366	115,230.0	684,462	862,108.0	-	-	-	-	-	-
2006	157,128	183,629.3	673,967	2,002,971.4	-	-	-	-	-	-
2007	167,181	389,532.2	696,115	2,048,451.6	-	-	87,627	0.3	-	-
2008	153,705	287,428.4	626,135	1,055,220.1	-	-	-	-	-	-
2009	167,204	260,838.2	712,496	1,068,744.0	-	-	-	-	-	-
2010	146,480	284,171.2	667,539	1,212,390.3	-	-	-	-	-	-
2011	113,649	247,755.2	696,793	1,379,649.2	5,000	8,609.3	1,058	0.0	-	-
2012	126,234	234,795.2	647,481	1,139,566.6	-	-	14,327	0.0	-	-
2013	126,707	245,811.6	665,318	1,157,653.3	-	-	77,240	0.3	-	-
2014	155,183	294,847.2	716,781	1,404,890.4	-	-	-	-	-	-
2015	151,247	245,126.5	686,938	1,204,315.0	-	-	-	-	-	-
2016	155,409	241,931.4	700,376	1,250,186.4	-	-	-	-	-	-
2017	140,683	288,118.8	649,889	1,639,020.1	-	-	-	-	-	-
2018	127,427	252,176.4	698,218	1,851,779.3	-	-	-	-	-	-
2019	133,424	233,202.7	665,889	1,486,129.0	-	-	-	-	-	-
2020	128,875	199,206.8	597,718	1,164,745.5	-	-	-	-	-	-
2021	127,208	254,416.0	608,395	1,654,834.4	-	-	-	-	-	-
Other <sup>e</sup>	-	-	-	-	71,946	17,091.9	-	-	-	-
<b>Total</b>	<b>3,857,323</b>	<b>\$5,001,661.7</b>	<b>18,502,429</b>	<b>\$30,197,643.4</b>	<b>673,548</b>	<b>\$57,333.1</b>	<b>1,394,994,184</b>	<b>\$245.3</b>	<b>39,051</b>	<b>\$3,426.7</b>

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

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

<sup>b</sup>Gold production adjusted to be more consistent with mining district production totals.

<sup>c</sup>76-lb flask.

<sup>d</sup>Crude platinum; total production of refined metal is about 575,000 oz.

<sup>e</sup>Not traceable by year

## APPENDIX C

Production of industrial minerals, coal, and other commodities in Alaska, 1880–2021<sup>a,b</sup>

Year	Coal		Sand and Gravel <sup>c</sup>		Rock <sup>d</sup>		Barite		Other <sup>e</sup>
	short tons	m\$	short tons	m\$	short tons	m\$	short tons	t\$	\$
1880–99	19,429	\$0.1	-	-	7,510	\$0.0	-	-	-
1900–09	33,214	0.2	-	-	15,318	0.2	-	-	\$246,403
1910–19	210,806	1.2	-	-	50,014	0.3	-	-	2,014,788
1920–29	937,860	5.2	-	-	494,417	2.7	-	-	2,523,754
1930–39	1,222,797	5.5	42,332	\$0.0	689,676	2.8	-	-	899,767
1940–49	3,189,026	20.2	1,758,504	0.7	286,341	1.3	-	-	27,124,158
1950–59	6,632,641	59.7	65,804,686	55.1	1,843,560	5.2	-	-	25,443,427
1960–69	7,849,000	58.8	163,315,000	176.7	2,034,000	4.2	225,000	\$1,200.0	34,143,000
1970–79	7,405,000	89.0	489,522,000	1,004.9	47,930,000	137.4	502,000	8,217.0	77,501,000
1980	800,000	16.0	40,000,000	86.0	3,700,000	15.4	50,000	2,000.0	97,500
1981	800,000	17.6	46,000,000	88.2	4,200,000	19.3	-	-	256,000
1982	830,000	18.0	45,000,000	91.0	3,400,000	15.6	-	-	150,000
1983	830,000	18.0	50,000,000	105.0	5,270,000	25.0	-	-	242,000
1984	849,161	23.8	27,000,000	95.0	2,700,000	16.0	-	-	875,875
1985	1,370,000	39.7	28,184,080	112.1	2,500,000	12.0	-	-	559,000
1986	1,492,707	40.1	20,873,110	75.8	4,200,000	20.3	-	-	384,800
1987	1,508,927	42.4	16,696,374	42.7	1,805,000	11.6	-	-	388,400
1988	1,551,162	44.3	17,264,500	48.8	3,600,000	24.7	-	-	389,000
1989	1,452,353	41.5	14,418,000	39.9	2,914,000	20.3	-	-	1,492,000
1990	1,576,000	45.0	15,013,500	40.8	3,200,000	22.1	-	-	400,000
1991	1,540,000	39.0	14,160,011	45.5	3,000,000	22.5	-	-	462,000
1992	1,531,800	38.3	14,599,746	42.2	2,900,000	23.0	-	-	430,000
1993	1,586,545	38.1	13,162,402	40.6	3,561,324	26.2	-	-	465,000
1994	1,490,000	36.8	13,518,321	41.0	3,843,953	27.0	-	-	459,500
1995	1,640,000	41.3	9,847,550	30.9	2,811,152	22.1	-	-	182,500
1996	1,481,000	38.0	9,890,463	32.2	3,000,045	23.6	-	-	200,000
1997	1,446,000	38.1	13,800,000	51.9	3,200,000	20.0	-	-	217,000
1998	1,339,000	35.2	12,363,450	57.3	1,636,200	14.0	-	-	215,000
1999	1,560,000	41.1	10,600,000	52.4	1,640,000	18.0	-	-	190,000
2000	1,473,355	38.8	10,600,000	49.9	5,200,000	36.6	-	-	203,000
2001	1,537,000	48.1	10,360,000	55.2	3,091,000	27.2	-	-	205,000
2002	1,158,000	37.4	22,412,000	120.7	3,152,000	31.4	-	-	200,000
2003	1,088,000	38.1	11,868,001	64.1	861,382	10.4	-	-	175,000
2004	1,450,000	50.8	19,576,092	101.5	7,312,050	106.2	-	-	2,732,554
2005	1,402,174	49.1	16,620,009	76.5	2,803,172	22.6	-	-	809,642
2006	1,397,500	48.9	13,953,465	63.4	2,369,738	23.8	-	-	1,057,500
2007	1,273,004	44.6	14,163,676	76.1	2,211,954	25.5	-	-	1,085,500
2008	1,538,000	53.8	12,461,685	72.4	2,485,820	39.5	-	-	1,159,502
2009	1,861,714	65.2	7,072,037	41.4	1,837,090	27.2	-	-	3,678,930
2010	2,061,000	72.1	6,977,297	48.0	290,852	4.3	-	-	2,303,950
2011	2,220,000	77.7	5,862,851	38.7	499,722	6.4	-	-	3,200,000
2012	2,018,759	70.7	7,799,994	52.3	1,050,762	15.8	-	-	-
2013	1,600,000	56.0	11,622,045	79.6	364,632	5.5	-	-	1,900,000
2014	1,500,000	52.5	9,215,300	63.2	1,147,869	17.2	-	-	120,000
2015	1,177,390	41.2	9,942,800	79.0	1,146,400	12.1	-	-	-
2016	930,987	32.6	9,557,000	74.3	825,630	15.3	-	-	-
2017	873,000	30.6	5,687,900	44.3	1,146,400	22.2	-	-	-
2018	1,000,000	35.0	7,639,000	55.2	1,543,200	27.8	-	-	-
2019	1,000,000	35.0	7,500,000	65.2	1,631,400	26.6	-	-	-
2020	1,020,870	51.0	6,724,000	56.9	1,554,300	13.4	-	-	-
2021	1,042,288	52.1	6,151,000	54.4	889,000	8.9	-	-	-
Other	-	-	-	-	2,300,000 <sup>f</sup>	W	79,000	W	-
<b>Total</b>	<b>84,797,469</b>	<b>\$2,013.1</b>	<b>1,386,600,180</b>	<b>\$3,888.9</b>	<b>162,146,883</b>	<b>\$1,078.8</b>	<b>856,000</b>	<b>\$11,417.0</b>	<b>\$196,782,450</b>

<sup>a</sup>From published and unpublished State and Federal documents. Where State and Federal figures differ significantly, State figures are used.

<sup>b</sup>Please refer to previous editions of this appendix for year-to-year production information for years 1900 to 1979.

<sup>c</sup>As of 2015, rock, sand, and gravel are reported as a combined commodity.

<sup>d</sup>Building-stone production figures for 1880–1937 are for the south-central and interior regions of Alaska only.

<sup>e</sup>Includes 2.4 million lb U<sub>3</sub>O<sub>8</sub> (1955–1971); 505,000 tons gypsum (1905–1926); 286,000 lb WO<sub>3</sub> (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).

<sup>f</sup>Marble quarried on Prince of Wales Island, southeastern Alaska (1900–1941).

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

## APPENDIX D

### Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Other grade	Other quantity
<b>KENSINGTON — Gold veins — Precious metals (gold) Source: Coeur Reports Year-End 2020 Mineral Reserves and Resources; Coeur Mining Annual Report dated February 14, 2022</b>																
Production	Proven	656,000							0.191	125.0						
Production	Probable	690,000							0.197	136.0						
Production	Measured	2,860,000							0.231	660.0						
Production	Indicated	1,263,000							0.256	323.0						
Advanced Exploration	Inferred	1,915,000							0.238	455.0						
	<b>Total</b>	<b>7,384,000</b>							<b>0.230</b>	<b>1,699.0</b>						
<b>LMS — Gold veins — Precious metals (gold) Source: NI 43-101 Technical Report on the LMS Gold Project, Goodpaster Mining District, Alaska; 43-101 technical report dated February 19, 2016</b>																
Exploration (0.5 g/t Au cut-off, open pit)	Inferred	9,170,000							0.029	267.0						
<b>POGO — Gold veins — Precious metals (gold) Source: Northern Star Resources Limited news release dated May 3, 2022</b>																
Production (as of March 31, 2022)	Probable	7,264,223							0.248	1,800						
Production (as of March 31, 2022; includes Probable reserves)	Indicated	10,551,311							0.321	3,400						
Production (as of March 31, 2022)	Inferred	14,074,294							0.280	3,931						
	<b>Total</b>	<b>24,625,605</b>							<b>0.298</b>	<b>7,331</b>						
<b>TERRA — Gold veins — Precious metals (gold, silver) Source: Technical Report on Resources, Terra Gold Project, McGrath District, Alaska; 43-101 technical report dated February 19, 2013</b>																
Exploration (5 g/tonne Au cut-off)	Indicated	128,913							0.386	49.8	0.87	112.7				
Exploration (5 g/tonne Au cut-off)	Inferred	811,286							0.456	369.8	0.81	653.9				
	<b>Total</b>	<b>940,199</b>							<b>0.446</b>	<b>419.6</b>	<b>0.82</b>	<b>766.6</b>				
<b>HERBERT GOLD — Gold veins — Precious metals (gold) Source: Grande Portage Resources Ltd. news release dated May 21, 2021</b>																
Exploration (0.088 ounce of gold per ton cut-off)	Indicated	4,009,101							0.299	1,196.8	0.17	686.7				
Exploration (0.088 ounce of gold per ton cut-off)	Inferred	1,254,429							0.260	325.9	0.14	169.3				
	<b>Total</b>	<b>5,263,530</b>							<b>0.290</b>	<b>1,522.7</b>	<b>0.16</b>	<b>856.0</b>				
<b>GOLDEN ZONE — Gold veins — Precious metals (gold, silver) Source: Technical Report on the Golden Zone Property, Valdez Creek Mining District, Central Alaska Range, South-Central Alaska; NI 43-101 technical report dated November 23, 2016 / amended August 17, 2017</b>																
Exploration (0.5 g/tonne Au cut-off)	Indicated	4,615,377							0.058	267.4	0.303	1,397.8				
Exploration (0.5 g/tonne Au cut-off)	Inferred	1,491,427							0.024	35.9	0.075	111.4				
	<b>Total</b>	<b>6,106,804</b>							<b>0.050</b>	<b>303.3</b>	<b>0.247</b>	<b>1,509.2</b>				
<b>LUCKY SHOT (Willow) — Gold veins — Precious metals (gold) Source: Preliminary Feasibility Study for the Lucky Shot Project, Matanuska-Susitna Borough, Alaska, USA; NI 43-101 technical report dated June 30, 2016</b>																
Development (7 g/tonne cut-off; subset of measured)	Proven	75,728							0.551	41.7	0.059	4.5				
Development (7 g/tonne cut-off; subset of indicated)	Probable	116,513							0.394	45.8	0.041	4.8				
Exploration (5 g/tonne Au cut-off)	Measured	63,823							0.782	49.9	0.073	4.7				
Exploration (5 g/tonne Au cut-off)	Indicated	163,802							0.438	71.6	0.047	7.4				
Exploration (5 g/tonne Au cut-off)	Inferred	65,036							0.540	35.1	0.044	2.9				
	<b>Total (resources only)</b>	<b>292,661</b>							<b>0.536</b>	<b>156.6</b>	<b>0.052</b>	<b>15.0</b>				
<b>SHOTGUN — Gold veins — Precious metals (gold) Source: Technical Report on the Shotgun Gold Project, Southwest Alaska; NI 43-101 technical report dated May 27, 2013</b>																
Exploration (0.015 ounce of Au/ton cut-off)	Inferred	22,860,000							0.031	706.0						
	<b>Total</b>	<b>22,860,000</b>							<b>0.031</b>	<b>706.0</b>						
<b>DONLIN — Intrusion gold — Precious metals (gold) Source: NovaGold Resources, Inc. Donlin Creek Gold Project, Alaska, USA, NI 43-101 Technical Report on Second Updated Feasibility Study; dated November 18, 2011, amended January 20, 2012</b>																
Development	Proven	8,468,971							0.068	573.0						
Development	Probable	547,984,194							0.061	33,276.0						
Development	Measured	52,910							0.074	53.0						
Development	Indicated	40,210,802							0.065	5,104.0						
Development	Inferred	101,649,697							0.059	5,993.0						
	<b>Total</b>	<b>698,366,574</b>							<b>0.061</b>	<b>45,000.0</b>						

## APPENDIX D, CONTINUED

### Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Other grade	Other quantity
<b>FORT KNOX — Intrusion gold — Precious metals (gold) Source: Kinross Gold Corp. annual report dated February 10, 2022</b>																
Production	Proven	38,371,411							0.009	375						
Production	Probable	216,686,588							0.009	2,092						
Production	Measured	8,471,252							0.009	77						
Production	Indicated	186,214,331							0.009	1,600						
Production	Inferred	93,774,614							0.006	672						
	<b>Total</b>	<b>543,518,196</b>							<b>0.008</b>	<b>4,816</b>						
<b>GIL — Intrusion gold — Precious metals (gold) Source: Fort Knox Mine, Fairbanks North Star Borough, Alaska, USA; NI 43-101 technical report dated June 11, 2018; effective date: December 31, 2017</b>																
Exploration	Indicated	32,535,782							0.016	533.0						
Exploration	Inferred	4,438							0.014	63.0						
	<b>Total</b>	<b>32,540,220</b>							<b>0.016</b>	<b>596.0</b>						
<b>GOLDEN SUMMIT — Intrusion gold - Precious metals (gold) Source: Golden Summit Project Preliminary Economic Assessment, Fairbanks North Star Borough, Alaska, USA; 43-101 technical report dated January 20, 2016</b>																
Exploration (Dolphin oxide deposit; 0.30 g/tonne cut-off)	Indicated	17,835,214							0.019	345.0						
Exploration (Dolphin oxide deposit; 0.30 g/tonne cut-off)	Inferred	10,604,126							0.017	183.0						
Exploration (Dolphin sulfide deposit; 0.30 g/tonne cut-off)	Indicated	49,912,144							0.020	1,018.0						
Exploration (Dolphin sulfide deposit; 0.30 g/tonne cut-off)	Inferred	68,210,324							0.020	1,401.0						
	<b>Total</b>	<b>146,561,808</b>							<b>0.020</b>	<b>2,947.0</b>						
<b>GRANT MINE (Ester Dome) - Intrusion gold - Precious metals (gold) Source: Technical Report on Ester Dome mineral resource estimation and Eagle Creek results, Fairbanks Mining District, Alaska; NI 43-101 technical report dated July 31, 2008</b>																
Exploration	Indicated	613,600							0.210	126.7						
	Inferred	2,553,400							0.080	214.1						
	<b>Total</b>	<b>3,167,000</b>							<b>0.105</b>	<b>340.8</b>						
<b>MONEY KNOB (Livengood) — Intrusion gold — Precious metals (gold) Source: Pre-Feasibility Study of the Livengood Gold Project, Livengood, Alaska, USA; 43-101 technical report dated December 17, 2021</b>																
Advanced Exploration	Proven	453,473,000							0.019	8,492.0						
Advanced Exploration	Probable	20,387,000							0.025	512.0						
Advanced Exploration	Measured	711,892,000							0.018	12,482.5						
Advanced Exploration	Indicated	64,478,020							0.018	1,141.6						
Advanced Exploration	Inferred	17,609,960							0.012	207.0						
	<b>Total</b>	<b>793,979,980</b>							<b>0.017</b>	<b>13,831.1</b>						
<b>NIXON FORK — Intrusion gold (skarn) — Precious metals (gold) Source: Technical Report on the Nixon Fork Mine Project, Medfra Quadrangle, Alaska; NI 43-101 technical report dated February 3, 2012</b>																
Development (past producer; lode, 5 g/tonne cut-off)	Indicated	270,427							0.481	130.0						
Development (past producer; lode, 5 g/tonne cut-off)	Inferred	118,200							0.512	60.5						
Development (past producer; tailings, 5 g/tonne cut-off)	Indicated	101,412							0.230	23.3						
Development (past producer; tailings, 5 g/tonne cut-off)	Inferred	52,910							0.210	11.4						
	<b>Total</b>	<b>542,949</b>							<b>0.414</b>	<b>225.2</b>						
<b>VINASALE — Intrusion gold — Precious metals (gold) Source: Technical Report for the Vinasale Mountain Prospect, McGrath Mining District, Alaska; 43-101 technical report dated March 31, 2013</b>																
Exploration	Indicated	3,760,000							0.043	162.0						
Exploration	Inferred	55,340,000							0.031	1,703.0						
	<b>Total</b>	<b>59,100,000</b>							<b>0.032</b>	<b>1,865.0</b>						
<b>ILLINOIS CREEK — Intrusion gold-silver-copper — Precious metals (gold, silver) Source: Western Alaska Copper and Gold website (<a href="https://www.wacg.rocks/projects/illinois-creek/">https://www.wacg.rocks/projects/illinois-creek/</a>); accessed August 31, 2020</b>																
Advanced Exploration	Indicated	7,450,000	0.18	26,820					0.030	226.0	1.00	7,500				
Advanced Exploration	Inferred	2,240,000	0.22	9,856					0.031	70.0	1.13	2,500				
	<b>Total</b>	<b>9,690,000</b>	<b>0.19</b>	<b>36,676</b>					<b>0.031</b>	<b>296.0</b>	<b>1.03</b>	<b>10,000</b>				

## APPENDIX D, CONTINUED

### Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Other grade	Other quantity
<b>NAOSI — Intrusion gold — Precious metals (gold) Source: Internal resource calculation presented to the American Exploration and Mining Association annual meeting, December 2019</b>																
Exploration Oxide (0.0102 oz/ton cut-off)	Indicated	11,697,714							0.049	576.0	0.79	9,274				
Exploration Sulfide (0.0146 oz/ton cut-off)	Indicated	6,715,193							0.063	421.0	0.82	5,498				
Exploration Oxide (0.0102 oz/ton cut-off)	Inferred	9,307,906							0.030	277.0	0.41	3,852				
Exploration Sulfide (0.0146 oz/ton cut-off)	Inferred	2,200,211							0.035	75.0	0.65	1,419				
Exploration Mon Ridge and Lone Wolf (0.0102 oz/ton cut-off)	Inferred	5,173,141							0.043	222.0	0.39	2,027				
<b>Total</b>		<b>35,094,165</b>							<b>0.042</b>	<b>1,571</b>	<b>0.65</b>	<b>22,070</b>				
<b>KORBEL — Intrusion gold — Precious metals (gold) Source: Nova Minerals Ltd. news release dated December 23, 2021</b>																
Exploration (0.15 g/t cut-off, Korbel Main)	Indicated	315,260,660							0.009	3,000.0						
Exploration (0.15 g/t cut-off, Korbel Main)	Inferred	642,646,730							0.009	5,100.0						
Exploration (0.30 g/t cut-off, RPM North)	Inferred	25,353,130							0.058	1,500.0						
<b>Total</b>		<b>983,260,520</b>							<b>0.010</b>	<b>9,600</b>						
<b>DELTA — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Bedrock Geologic Map of the Delta Mineral Belt, Tok Mining District, Alaska (DGGs PR 122); 2003</b>																
Exploration (DW/Mid/Nunatak/LP)	Inferred	9,400,000	0.4	75,200	1.75	329,000	4.61	866,680	0.047	441.9	1.85	17,402				
Exploration (PP2)	Inferred	5,900,000	0.4	47,200	2.1	247,800	4.6	542,800	0.050	292.9	2.07	12,232				
Exploration (DDS)	Inferred	2,300,000	1.1	50,600	2.6	119,600	6.5	299,000	0.070	161.2	2.98	6,850				
Exploration (DDN)	Inferred	1,200,000	1.6	38,400	2.4	57,600	2.3	55,200	0.093	112.1	2.98	3,574				
<b>Total</b>		<b>18,800,000</b>	<b>0.6</b>	<b>211,400</b>	<b>1.9</b>	<b>754,000</b>	<b>4.5</b>	<b>1,763,680</b>	<b>0.048</b>	<b>1,008.1</b>	<b>1.96</b>	<b>40,058</b>				
<b>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</b>																
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				
<b>Total</b>		<b>10,031,033</b>	<b>0.1</b>	<b>26,455</b>	<b>2.6</b>	<b>515,872</b>	<b>5.8</b>	<b>1,170,655</b>	<b>0.027</b>	<b>261.0</b>	<b>4.59</b>	<b>46,100</b>				
<b>GREENS CREEK — Massive sulfide — Polymetallic (lead, zinc, gold, silver) Source: Hecla Mining Company 2021 Annual Report</b>																
Production	Proven	2,000			1.70	60	4.50	160	0.080	0.1	9.60	18				
Production	Probable	11,074,000			2.50	564,440	6.60	1,451,660	0.090	946.0	11.30	125,201				
Production	Measured															
Production	Indicated	8,355,000			3.00	500,080	8.40	1,403,040	0.100	836.0	12.80	106,670				
Production	Inferred	2,152,000			2.80	120,280	6.80	292,040	0.080	164.0	12.80	27,508				
<b>Total</b>		<b>21,583,000</b>			<b>2.72</b>	<b>1,184,860</b>	<b>7.32</b>	<b>3,146,900</b>	<b>0.093</b>	<b>1,946.1</b>	<b>12.03</b>	<b>259,397</b>				
<b>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</b>																
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				
<b>Total</b>		<b>9,955,000</b>	<b>0.81</b>	<b>178,780</b>			<b>1.29</b>	<b>311,354</b>	<b>0.039</b>	<b>384.0</b>	<b>0.59</b>	<b>5,843</b>				
<b>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</b>																
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			Barite (%)	Thousands of pounds
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			23.9	2,464,765
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			22.0	2,588,224
<b>Total</b>		<b>15,731,066</b>	<b>0.9</b>	<b>278,000</b>	<b>0.3</b>	<b>90,000</b>	<b>5.04</b>	<b>1,586,000</b>	<b>0.011</b>	<b>166</b>	<b>1.65</b>	<b>26,000</b>			<b>26.4</b>	<b>8,315,827</b>

## APPENDIX D, CONTINUED

### Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Other grade	Other quantity
<b>JOHNSON TRACT — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Initial Mineral Resource Estimate for the Johnson Tract Project, Alaska; 43-101 technical report dated April 29, 2020</b>																
Exploration (4.0 g/t gold-equivalent cutoff)	Indicated	2,353,432	0.57	26,800	0.80	37,600	5.85	275,300	0.177	417.0	0.17	397				
Exploration (4.0 g/t gold-equivalent cutoff)	Inferred	640,442	0.54	6,900	0.33	4,200	6.67	85,500	0.060	38.0	0.25	162				
	<b>Total</b>	<b>2,993,874</b>	<b>0.56</b>	<b>33,700</b>	<b>0.70</b>	<b>41,800</b>	<b>6.03</b>	<b>360,800</b>	<b>0.152</b>	<b>455.0</b>	<b>0.19</b>	<b>559</b>				
<b>RED DOG — Massive sulfide — Base metals (lead, zinc, silver) Source: Reserves and resources as of December 31, 2021. <a href="https://www.teck.com/media/2022-AIF.pdf">https://www.teck.com/media/2022-AIF.pdf</a>, accessed on April 3, 2024</b>																
Production (Aqqaluk, Qanaiyaq)	Probable	47,289,099			3.6	1,763,696	12.6	9,942,836			1.96	53,130				
Production (Aqqaluk, Qanaiyaq)	Indicated	10,031,021			5.0	1,003,102	7.5	1,504,653			2.52	25,278				
Production (Aqqaluk, Qanaiyaq)	Inferred	10,141,252			4.3	872,148	12.4	2,515,030			2.56	25,941				
	<b>Total</b>	<b>67,461,372</b>			<b>3.9</b>	<b>3,638,946</b>	<b>11.8</b>	<b>13,962,520</b>			<b>2.13</b>	<b>104,348</b>				
<b>ANARRAAQ — Massive sulfide — Base metals (lead, zinc, silver) Source: Reserves and resources as of December 31, 2021. <a href="https://www.teck.com/media/2022-AIF.pdf">https://www.teck.com/media/2022-AIF.pdf</a>, accessed on April 3, 2024</b>																
Exploration	Inferred	21,384,814			4.2	1,796,324	14.4	6,158,826			2.14	45,834				
<b>ANARRAAQ — Bedded 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.</b>																
															<b>Barite (%)</b>	<b>Thousands of pounds</b>
Exploration (barite grade unspecified)	Inferred	1,100,000,000													?	?
<b>LIK — Massive sulfide — Base metals (lead, zinc, silver) Source: Preliminary Economic Assessment Technical Report, Zazu Metals Corporation, Lik Deposit, Alaska; dated April 23, 2014</b>																
Advanced Exploration (Lik South, in pit, 5% Zn+Pb cut-off)	Indicated	18,570,000			2.70	1,003,000	8.04	2,986,000			1.463	27,170				
Advanced Exploration (Lik North, in pit, 5% Zn+Pb cut-off)	Indicated	490,000			2.77	27,000	10.03	98,000			1.723	840				
Advanced Exploration (Lik South, other, 7% Zn+Pb cut-off)	Indicated	760,000			3.15	48,000	8.04	122,000			1.489	1,130				
Advanced Exploration (Lik North, other, 7% Zn+Pb cut-off)	Indicated	140,000			2.93	8,000	8.93	25,000			1.095	150				
Advanced Exploration (Lik South, in pit, 5% Zn+Pb cut-off)	Inferred	820,000			1.94	32,000	7.73	127,000			0.391	320				
Advanced Exploration (Lik North, in pit, 5% Zn+Pb cut-off)	Inferred	2,350,000			2.94	138,000	8.88	417,000			1.337	3,140				
Advanced Exploration (Lik South, other, 7% Zn+Pb cut-off)	Inferred	560,000			1.59	18,000	6.97	78,000			0.330	180				
Advanced Exploration (Lik North, other, 7% Zn+Pb cut-off)	Inferred	2,160,000			2.99	129,000	9.22	398,000			1.337	2,890				
	<b>Total</b>	<b>25,850,000</b>			<b>2.72</b>	<b>1,403,000</b>	<b>8.23</b>	<b>4,251,000</b>			<b>1.163</b>	<b>35,820</b>				
<b>ARCTIC — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Arctic Feasibility Study, Alaska, USA, NI 43-101 Technical Report; dated August 20, 2020</b>																
Advanced Exploration (in pit, 0.5% Cu-equivalent cut off)	Probable	47,887,653	2.24	2,145,367	0.54	517,187	3.12	2,988,190	0.014	657.2	1.01	48,522				
Advanced Exploration (in pit, 0.5% Cu-equivalent cut off)	Inferred	3,858,085	1.71	131,000	0.60	47,000	2.72	210,000	0.011	40.0	0.84	3,000				
	<b>Total</b>	<b>51,745,738</b>	<b>2.20</b>	<b>2,276,367</b>	<b>0.54</b>	<b>564,187</b>	<b>3.09</b>	<b>3,198,190</b>	<b>0.013</b>	<b>697.2</b>	<b>1.00</b>	<b>51,522</b>				
<b>BORNITE — Massive sulfide — Polymetallic (carbonate-hosted copper, cobalt) Source: NI 43-101 Technical Report on the Bornite Project, Northwest Alaska, USA; report dated June 5, 2018</b>																
															<b>Co (%)</b>	<b>Thousands of pounds</b>
Exploration (in pit, 0.5% Cu cut-off)	Indicated	44,643,555	1.02	913,000												
Exploration (in pit, 0.5% Cu cut-off)	Inferred	92,704,271	0.95	1,768,000											0.017	45,000
Exploration (below pit, 1.5% Cu cut-off)	Inferred	63,713,518	2.89	3,683,000											0.025	32,000
	<b>Total</b>	<b>201,061,344</b>	<b>1.58</b>	<b>6,364,000</b>											<b>0.020</b>	<b>77,000</b>
<b>SUN — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Valhalla Metals Inc. news release August 22, 2018</b>																
Exploration (\$75/tonne cut-off)	Indicated	1,888,257	1.48	55,846	1.11	42,035	4.32	162,962	0.006	12.0	1.75	3,307				
Exploration (\$75/tonne cut-off)	Inferred	9,940,632	1.21	239,643	1.46	290,258	4.18	831,334	0.007	73.0	2.39	23,681				
	<b>Total</b>	<b>11,828,889</b>	<b>1.25</b>	<b>295,489</b>	<b>1.40</b>	<b>332,293</b>	<b>4.20</b>	<b>994,296</b>	<b>0.007</b>	<b>85</b>	<b>2.28</b>	<b>26,988</b>				
<b>SMUCKER — Massive sulfide — Polymetallic (copper, lead, zinc, gold, silver) Source: Historical resource from Anaconda Copper Mining Company, Internal Report, 1981; cited in Trilogy Metals news release dated March 19, 2019</b>																
Exploration	Inferred	12,786,796	0.95	242,949	2.3	588,193	6.4	1,636,710	0.025	324.8	4.78	61,084				



## APPENDIX D, CONTINUED

### Identified mineral resources of Alaska deposits

DEPOSIT—Type—Metal Suite																
Phase	Category	Short Tons of Resource	Cu %	Cu thousand pounds	Pb %	Pb thousand pounds	Zn %	Zn thousand pounds	Au oz/ton	Au thousand ounces	Ag oz/ton	Ag thousand ounces	Mo %	Mo thousand pounds	Other grade	Other quantity
<b>HORSE CREEK — Massive sulfide — Polymetallic (copper, lead, zinc, silver) Source: Historical resource from Kennecott Mines Company, Internal Report, 1985; cited in Trilogy Metals news release dated March 19, 2019</b>																
Exploration	Historical	11,000,000	1.00	220,000	2	440,000	3	660,000			0.91	9,957				
<b>SUNSHINE — Massive sulfide — Polymetallic (copper, lead, zinc, silver) Source: Historical resource from Kennecott Mines Company, Internal Report, 1997; cited in Trilogy Metals news release dated March 19, 2019</b>																
Exploration	Inferred	22,000,000	1.40	616,000	0.5	220,000	2.5	1,100,000			0.76	16,767				
<b>SHUNGNAK — Massive sulfide — Polymetallic (copper, zinc, silver) Source: Historical resource from Bear Creek Mining Company, Internal Report, 1983; cited in Trilogy Metals news release dated March 19, 2019</b>																
Exploration	Inferred	1,100,000	3.00	66,000			2	44,000			1.82	1,998				
<b>BT — Massive sulfide — Polymetallic (copper, lead, zinc, silver) Source: Historical resource from Kennecott Mines Company, Internal Report, 1997; cited in Trilogy Metals news release dated March 19, 2019</b>																
Exploration	Inferred	3,800,000	1.70	129,200	0.9	68,400	2.6	197,600			1.18	4,483				
<b>CARIBOU DOME — Sediment-hosted — Base metals (copper) Source: High-Grade Initial JORC Resource Estimate -- Caribou Dome; Coventry Resources news release dated April 5, 2017</b>																
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												
	<b>Total</b>	<b>3,082,059</b>	<b>3.1</b>	<b>189,596</b>												
<b>PEBBLE — Porphyry — Polymetallic (copper, gold, silver, molybdenum) Source: 2020 Technical Report on the Pebble Project, Southwest Alaska, USA; August 18, 2020</b>																
															<b>Re (ppm)</b>	<b>Thousands of pounds</b>
Advanced Exploration (0.3 CuEq cut-off)	Measured	580,912,100	0.33	3,830,000					0.010	5,930	0.050	28,100	0.0178	210,000	0.32	368
Advanced Exploration (0.3 CuEq cut-off)	Indicated	6,535,536,700	0.41	53,580,000					0.010	64,810	0.050	316,400	0.0246	3,200,000	0.41	5,386
Advanced Exploration (0.3 CuEq cut-off)	Inferred	4,909,644,200	0.25	24,540,000					0.007	35,800	0.035	170,400	0.0226	2,180,000	0.36	3,534
	<b>Total</b>	<b>12,026,093,000</b>	<b>0.341</b>	<b>81,950,000</b>					<b>0.009</b>	<b>106,540</b>	<b>0.044</b>	<b>514,900</b>	<b>0.0235</b>	<b>5,590,000</b>	<b>0.39</b>	<b>9,288</b>
<b>PYRAMID — Porphyry — Polymetallic (copper, gold, molybdenum) Source: NI 43-101 Technical Report for the Pyramid Project, Alaska Peninsula, Alaska; report dated January 2018</b>																
Main Zone (0.20% Cu-equivalent cut-off)	Inferred	155,315,479	0.38	1,186,000					0.003	442.0			0.022	68,000		
West Zone (0.20% Cu-equivalent cut-off)	Inferred	13,778,875	0.28	76,000					0.002	14.0			0.010	2,000		
	<b>Total</b>	<b>169,094,354</b>	<b>0.37</b>	<b>1,262,000</b>					<b>0.003</b>	<b>456.0</b>			<b>0.021</b>	<b>70,000</b>		
<b>SHUMAGIN (UNGA PROJECT) — Epithermal — Precious metals (gold, silver) Source: Redstar Gold Corp. news release dated February 10, 2020</b>																
Exploration (3.5 g/t cut-off)	Inferred	954,617							0.403	384.3	1.034	986.3				
<b>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</b>																
Exploration	Inferred	4,780,000							0.042	200.0						
<b>MANH CHOI — Main and North Peak Skarn — Polymetallic (copper, gold, silver) Source: Kinross Gold 2021 annual report dated February 21, 2022, with Copper values from Royal Gold news release dated September 24, 2018</b>																
Exploration (0.74, 0.66 g/tonne Au-equiv. cut-off: Main, North)	Measured	364,762	0.148	1,500					0.187	68.0	0.488	178.0				
Exploration (0.74, 0.66 g/tonne Au-equiv. cut-off: Main, North)	Indicated	6,733,220	0.153	29,500					0.117	778.0	0.412	2,762.0				
Exploration (0.5 g/tonne Au-equiv. cut-off?)	Inferred	1,036,982	0.151	31,000					0.079	81.0	0.470	486.0				
	<b>Total</b>	<b>8,134,964</b>	<b>0.153</b>	<b>62,000</b>					<b>0.115</b>	<b>927.0</b>	<b>0.423</b>	<b>3,426.0</b>				
<b>RAINTREE WEST — Porphyry — Polymetallic (copper, gold, silver) Source: NI 43-101 Resource Estimate for the Whistler Project; report dated June 11, 2021</b>																
Exploration (Pit-constrained)	Indicated	8,598,018	0.09	15,000					0.014	100.0	0.143	1,200				
Exploration (Underground)	Indicated	2,976,237	0.13	8,000					0.023	100.0	0.122	400				
Exploration (Pit-constrained)	Inferred	13,007,260	0.07	18,000					0.018	200.0	0.134	1,700				
Exploration (Underground)	Inferred	43,871,940	0.12	107,000					0.023	1,000.0	0.073	3,200				
	<b>Total</b>	<b>68,453,455</b>	<b>0.11</b>	<b>148,000</b>					<b>0.021</b>	<b>1,400</b>	<b>0.096</b>	<b>6,500</b>				
<b>ISLAND MOUNTAIN — Porphyry — Polymetallic (copper, gold, silver) Source: NI 43-101 Resource Estimate for the Whistler Project; report dated June 11, 2021</b>																
Exploration (Pit-constrained)	Inferred	123,348,500	0.05	131,000					0.014	1,700.0	0.031	3,800				
	<b>Total</b>	<b>123,348,500</b>	<b>0.05</b>	<b>131,000</b>					<b>0.014</b>	<b>1,700.0</b>	<b>0.031</b>	<b>3,800</b>				



Mining districts <sup>a</sup>	Production (in refined troy ounces)		
	Total	Placer	Lode
1 Lisburne district	0	0	0
2 Noatak district	7,800	7,800	0
3 Wainwright district	0	0	0
4 Barrow district	0	0	0
5 Colville district	0	0	0
6 Canning district	0	0	0
7 Sheenjek district	0	0	0
8 Chandalar district	70,278	52,878	17,400
9 Koyukuk district	378,075	378,075	0
10 Shungnak district	15,000	15,000	0
11 Kiana & Selawik districts	40,607	40,607	0
12 Fairhaven district (Candle subdistrict)	254,265	254,265	0
13 Fairhaven district (Inmachuk subdistrict)	349,975	349,975	0
14 Serpentine district	4,536	4,536	0
15 Port Clarence district	42,358	42,358	0
16 Kougarok district	191,712	191,712	0
17 Nome (Cape Nome) district	5,043,465	5,043,465	0
18 Council district	1,047,042	1,020,042	27,000
19 Koyuk district	84,462	84,462	0
20 Hughes district	403,671	403,671	0
21 Kaiyuh district	149,703	5,400	144,303
22 Anvik district	7	7	0
23 Marshall district	124,506	124,506	0
24 Bethel district	42,953	42,953	0
25 Goodnews Bay district	31,202	31,202	0
26 Aniak district	613,407	613,407	0
27 Iditarod district	1,565,226	1,562,296	2,930
28 McGrath district	364,672	133,307	231,365
29 Innoko district	757,219	757,063	156
30 Ruby district	478,023	478,023	0
31 Kantishna district	99,307	91,401	7,906
32 Hot Springs district	604,926	604,926	0
33 Melozitna district	14,630	14,630	0
34 Rampart district	204,845	204,845	0
35 Tolovana district	547,556	547,556	0
36 Yukon Flats district	0	0	0
37 Circle district	1,125,341	1,125,341	0
38 Black district	2	2	0
39 Eagle district	52,166	52,166	0
40 Fortymile district	602,758	602,758	0
41 Chisana district	144,521	78,021	66,500
42 Tok district	288	288	0
43 Goodpaster district	4,256,781	2,051	4,254,730
44 Fairbanks district	16,863,096	8,282,595	8,580,501

Mining districts <sup>a</sup>	Production (in refined troy ounces)		
	Total	Placer	Lode
45 Bonfield district	108,983	102,283	6,700
46 Richardson subdistrict of Fairbanks district <sup>b</sup>	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 <sup>c</sup>	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 <sup>d</sup>	13,200	2,200	11,000
63 Juneau district (partial)	82,540	82,540	0
64 Admiralty (64b) & Juneau (64a) districts	10,775,121	82,390	10,692,731
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) <sup>e</sup>	306,932	303,738	3,194
<b>TOTAL (refined Troy ounces)</b>	<b>51,005,701</b>	<b>25,208,104</b>	<b>25,797,597</b>
<b>(1,586 metric tons)</b>			

<sup>a</sup>Mining district names and boundaries revised slightly from those defined by Ransome and Kerns (1954) and Cobb (1973). Sources of data: U.S. Geological Survey, U.S. Bureau of Mines, and Alaska Territorial Department of Mines records 1880–1930; U.S. Mint records 1930–1969; State of Alaska production records 1970–2020. Entries of "0" generally mean no specific records are available.

<sup>b</sup>Not included in total for Fairbanks district.

<sup>c</sup>Most placer gold production included in Willow Creek district.

<sup>d</sup>Includes lode production from Glacier Bay area and placer production from Lituya Bay area.

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

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

