Metal Mining in Alaska

Small, high-value industry with a long history here is growing

By **SARA TEEL**

Mining is a colorful part of Alaska's past. There are ghost town tours of Kennecott Mine, Skagway exists and thrives because of its gold rush history, and Treadwell Mine tailings created Sandy Beach in Juneau. But mining is also an important part of Alaska's current economy and will almost certainly play a growing role in its future.

For more than a century, Alaska has produced a variety of minerals, especially metals produced from hard rock. Today, Alaska only produces gold, silver, lead, and zinc in large quantities. In fact, Alaska was the top silver producer in the U.S. in 2017, and zinc and lead were the state's top two foreign exports. (See the sidebar on page 7 for a list of all metals ever produced in the state and those we're likely to mine in the future.)

The main metal mines

Alaska has five large-scale metal mines in production: Pogo, Red Dog, Kensington, Greens Creek, and Fort Knox. (See Exhibit 1.) Another 205 mostly small placer operations reported gross operating income in 2017.

Types of metal mines and typical extraction techniques in Alaska

Metallic ores include ferrous (iron-containing) ores such as steel; nonferrous ores such as copper, tin, lead and zinc; and precious metals such as gold, silver, and platinum. This article excludes nonmetallic minerals (sand and gravel) and energy minerals (coal and petroleum).

Many lodes are difficult to access and require ground level or underground mining to reach targeted deposits using drilling or explosives. The mined rock often contains other material, so extracting the desired metal mechanically or chemically often requires crushing or pulverizing the rock.

Large mines in Alaska are mainly open pit or underground. Open pit mines extract rock or minerals relatively close to the surface through an open pit or burrow. This results in a large telescoping hole, the depth of which depends on the amount of recoverable ore and its profitability. Open pits are used to access vertical ore deposits.

Underground mines access ore deposits buried deeper in the earth when the value of the ore exceeds the incurred cost.

Miners use a range of techniques to extract the ore, often employing multiple methods over the life of a mine. The choice depends on the ore's characteristics (such as mineral type, thickness, dip, grade, and uniformity) as well as the depth, safety, cost, and likely recovery of the mineral.

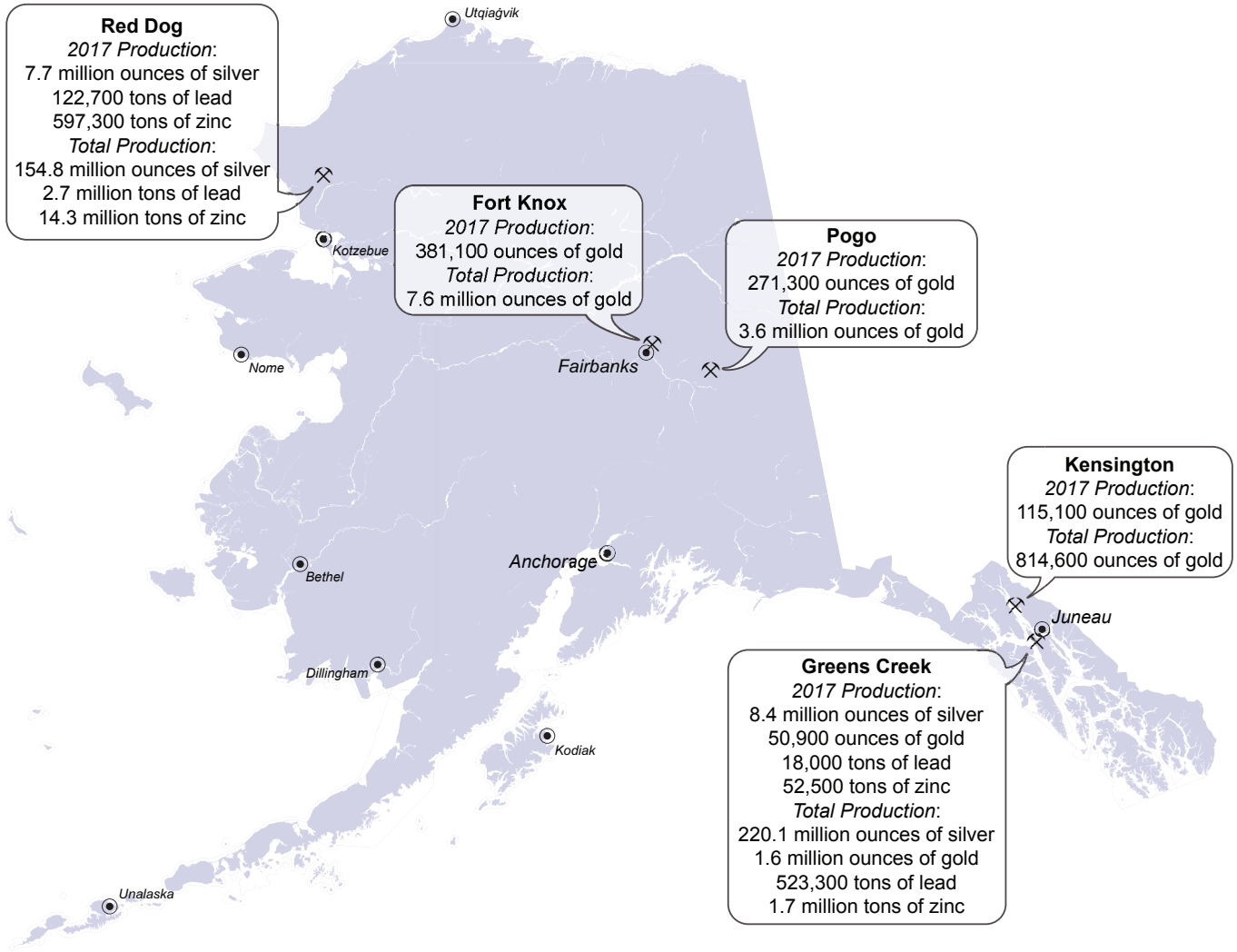
Common methods used in Alaska are:

- Stoping: The process of extracting the desired ore or other mineral from an underground mine, leaving behind an open space called a stope. The stope may be artificially supported or backfilled.
- Cut-and-fill: Also used in underground mining, usually for steep ore deposits. The ore is mined horizontally from the bottom, and then the gap is backfilled with waste rock, sand, or tailings. This becomes a platform for the layers above.
- Drift-and-fill: This variation of cut-and-fill is used for wider ore deposits.
- Truck-and-shovel/truck-and-loader: In open pit mines, workers unearth material with shovels or loaders, then transport it by truck.

Another notable type of mining is placer, which is usually associated with gold. Placer mines use water to excavate, transport, concentrate, and recover minerals, utilizing differences in density. Placer mining is the oldest form of mining in Alaska and these mines can range from mom-and-pop outfits to large operations, although most are small. Well-known placer mining methods are dredging and panning.

1 Alaska's Main Metal Mines and Their Production

2017



Source: Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys: Alaska's Mineral Industry 2017

(See the sidebar on the previous page for mine types and the extraction techniques used in Alaska.)

- Fort Knox Mine, 20 miles outside of Fairbanks, is Alaska's largest surface gold mine. It was discovered in 1984 and has been producing continuously since 1996. Fort Knox is an open pit mine that uses a truck-and-shovel operation.
- Pogo Mine is an underground gold mine about 130 miles from Fairbanks. Discovered in 1994, the mine began producing in 2006. Pogo is a cut-and-fill operation.
- Red Dog Mine, 82 miles from Kotzebue, has one of the largest open-pit zinc deposits in the world. Red Dog also produces lead and, to a lesser extent, silver. It was discovered in 1968 and has been producing since 1989. Red Dog is a truck-and-loader operation.
- Greens Creek Mine, on Admiralty Island about 18 miles from Juneau, is in the Tongass National Forest. It's an underground mine that produces silver, zinc, gold, and lead through cut-and fill and long hole stoping. Greens Creek was discovered in 1975, produced from 1989 through 1993, then resumed continuous production in 1996.
- Kensington Mine is an underground long hole stop-

ing and drift-and-fill gold mine 45 miles north of Juneau near Lynn Canal. It has been producing continuously since 2010.

Zinc is now more valuable than gold

The thought of valuable metals may conjure the image of heavily laden lines of prospectors climbing Chilkoot Pass during the Klondike Gold Rush in a mad dash for discovery riches. But while gold continues to provide a lucrative revenue stream, Alaska's zinc production value has surpassed that of gold by 10 percent over the last decade.

Zinc and its concentrates were also Alaska's top foreign export in 2017, followed by lead ore and its concentrates at a distant second. (See Exhibit 2.)

2 Export Value of Alaska Metals

AND RANK AMONG ALL OF ALASKA'S FOREIGN EXPORTS IN 2017

		Value* in millions of dollars			
Rank	Description	2014	2015	2016	2017
1	Zinc Ores and Concentrates	$1,106	$917	$864	$1,231
2	Lead Ores and Concentrates	$380	$338	$391	$431
12	Precious Metals Ores/Concentrates, Exc Silver	$145	$159	$151	$131

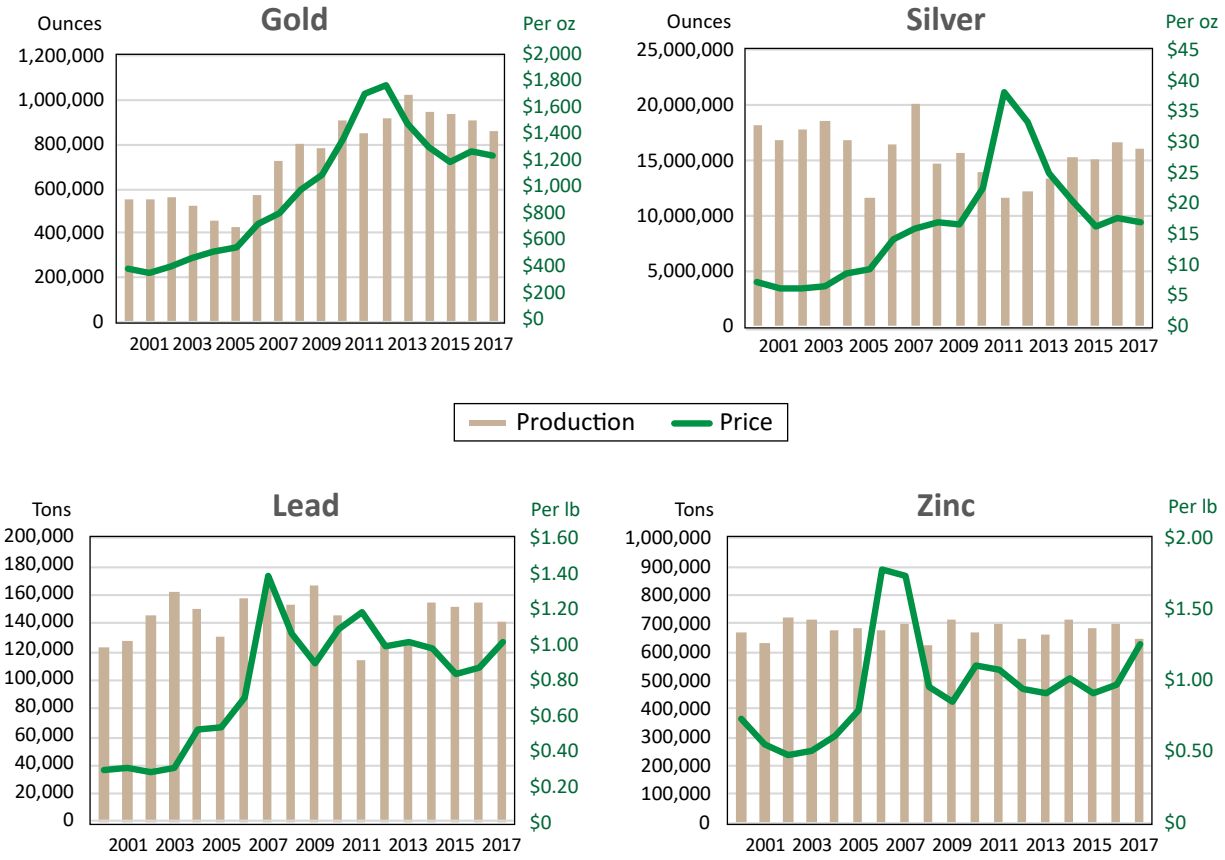
*Adjusted to 2017 dollars
Source: U.S. Census Bureau foreign trade statistics

Production and price have a complex relationship

While gold and silver have been mined continuously in Alaska since the late 1800s, significant production of lead and zinc began just over three decades ago with the commercial success of the Northwest Arctic

3 Production and Prices of Alaska's Main Metals

2000 TO 2017, PRICES ADJUSTED TO 2017 DOLLARS



Source: Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys: Alaska's Mineral Industry 2017

Alaska's current and historically mined metals, and future possibilities

Metals Alaska produced in 2017	
Gold (Au)	Gold has been mined in Alaska since the 1870s. Forty percent of domestic use is for jewelry, 35 percent is electrical and electronics, and 20 percent is coins. Gold is also used in dental applications. Alaska ranks ninth globally for known gold deposits.
Lead (Pb)	Minor amounts of lead have been mined in Alaska since the 1880s, but significant production began in 1989, aside from a brief swell from the 1910s to 1940s. The lead-acid based industry consumes approximately 85 percent of Alaska's mined lead. It's also used in ammunition and alloys such as bronze. Environmental and health concerns have reduced its role in gasoline, paint additives, solder, and pipes. As of 2017, Alaska ranked sixth globally for known lead deposits.
Silver (Ag)	Silver is used in emerging medical and hygiene applications such as bandages and clothing and in the manufacturing of coins, jewelry, and soldering. It's also used in the declining print photography market. As of 2017, Alaska ranked 10th globally for known silver deposits.
Zinc (Zn)	Before the Red Dog Mine opened in 1989 and raised production levels significantly, zinc had a brief production stint from 1947 to 1949. Most domestic use is for galvanizing. As of 2017, Alaska ranked seventh globally for known zinc deposits.

Metals Alaska produced in the past	
Antimony (Sb)	Used in flame retardants and shrapnel alloys, antimony was produced from 1914 to 1918 and again in 1937, then sporadically until the mid-1980s. Antimony is also used in lead-acid batteries and plastic.
Barite (BaSO4)	Barite contains barium, an earth metal produced from the 1960s to 1980. Barite is a weighting agent in fluids used in the drilling of oil and gas wells. It can also be a contrast medium for x-ray and tomography exams of the gastrointestinal tract.
Chromium (Cr)	Chromium, a transition metal, is an ingredient in stainless steel and was produced in Alaska in small amounts from 1942 to 1943 and again from 1954 to 1957.
Copper (Cu)	Copper production started in 1901 and peaked in 1916 with the help of Kennecott Mine near McCarthy, then petered out by the 1960s. Most copper is used in construction and electronics, but it's also used for machinery and consumer products. Electric vehicle production could boost demand for copper in the coming years. As of 2017, Alaska ranked 11th globally for known copper deposits.
Mercury (Hg)	Alaska produced some mercury, a transition metal, from 1940 to 1973. This toxic metal was historically used in thermometers, batteries, cosmetics, and paint. Due to Environmental Protection Agency restrictions, mercury is now mainly limited to use in chlorine caustic soda. It occurs as a byproduct of gold mining and was once used to separate gold from placer gravels.
Platinum (Pt)	Platinum is a byproduct of copper mining that was dredged in Southwest Alaska for about 40 years beginning in 1926. It's used as a catalyst for air pollution abatement in vehicles and in chemical and electronic technologies as well as in jewelry.
Tin (Sn)	Tin production in Alaska reportedly began in 1902 and ceased in 1993. Tin was used for tin cans, containers, electronics, vehicles, and solder. It was also used in construction.
Tungsten (W)	Tungsten was produced in Alaska intermittently from 1916 to 1980. Nearly 60 percent of the tungsten used in the U.S. was in cemented carbide parts for cutting and wear-resistant applications, primarily in the construction, metal working, mining, and oil and gas drilling industries.
Uranium (U)	Uranium was produced in Alaska from 1955 to 1971.

Metals Alaska is likely to produce in the future	
Molybdenum (Mo)	While there is no history of molybdenum production in Alaska, it is a prospective product of the Pebble Mine Project, which is in the advanced exploration phase. Molybdenum is used in steel alloys and superalloys.
Rare Earth Elements (REEs)	Rare earth elements are composed of the lanthanide series. They have a silver appearance and can be difficult to extract. REEs are used in national defense technology, petroleum refining, and air pollution control. The Bokan-Dotson Ridge Project on Prince of Wales Island, which is in the advanced exploration phase, shows potential for REEs including dysprosium, terbium, and yttrium.

Sources: Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys; and United States Geological Survey, Mineral Commodity Summaries 2017

Borough's Red Dog Mine.

Since 2000, only gold production has significantly increased in volume. This is the result of Pogo coming online in 2006 and Kensington in 2010. Zinc production remained relatively flat over that period, while silver and lead production bounced around. (See Exhibit 3.)

Price and production don't always track together, as the relationship is complicated. High startup and operational costs, the time it takes from discovery to start of production, and regulatory obligations mean short-term price volatility doesn't usually affect short-term production. Mines can't promptly shut down when prices fall, nor can they quickly expand when prices jump. Some mines also produce multiple metals, so changes in an individual metal's price or production level can have a lesser effect on operational decision-making.

On the other hand, commodity prices have a direct

relationship with total production value. Since 2000, prices for all four metals have grown steadily, marked by occasional price spikes due to market volatility. (See Exhibit 3.)

Commodity price increases coupled with large production volumes have led to significant growth in production value, even when year-to-year changes in volume were modest. This was the case with zinc and gold. From 2008 to 2017, zinc's production value grew by 36 percent but production only rose 4 percent. Gold's trend was similar, with value increasing 34 percent but production up only 7 percent. (See Exhibit 4.)

Silver and lead are worth less and their production value gains were also more modest. Silver recorded 10 percent growth in value and production, and lead's production and value fell by 8 percent and 12 percent, respectively, over the 2008-2017 period.

Small but growing industry pays high average wages

In 2017, Alaska had an average of 2,688 jobs in metal mining and more than $296 million in total wages. The industry paid among the highest average wages in the state, behind oil and gas, at $110,171. (See Exhibit 5.) This was more than double the state's average wage that year.

From 2008 to 2017, metal mining employment grew 36 percent and its wages rose 44 percent. This was in stark contrast to Alaska's total employment, which grew just 2 percent while total wages rose 5 percent.

While metal mining has increased its presence in Alaska, these jobs remain a small fraction of total employment and wages. In 2008, metal mining represented 0.6 percent of Alaska employment, which grew to 0.8 percent in 2017. Wages grew from 1.2 percent of the total to 1.7 percent.

By mineral, the highest average wage in 2017 was $114,296 for silver, lead, or zinc mining, and gold mining wasn't far behind at $109,229. Metal mining support jobs paid an average of $89,088.

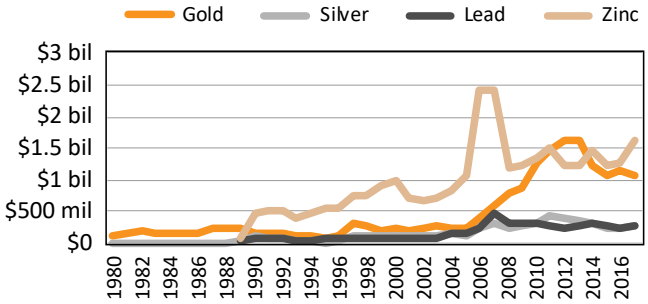
In terms of wage distribution by worker, 53 percent of metal mining workers made less than $90,000 per year, 26 percent averaged between $90,000 and $120,000, and 22 percent made more than $120,000 per year. (See Exhibit 6.)

Most jobs, wages are in gold

Three of Alaska's five main mines produce only gold, so gold mining makes up almost two-thirds of total metal mining employment and wages.

4 Metal Production Values

ALASKA, 1980 TO 2017, IN 2017 DOLLARS



Source: Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys: Alaska's Mineral Industry 2017

5 Small Industry, High Wages

SELECT ALASKA INDUSTRIES, 2017

Industry	Jobs	Avg wage	Total wages
Oil and Gas	9,753	$135,458	$1,321,118,766
Metal Mining	**2,688**	**$110,171**	**$296,140,024**
Utilities	2,116	$86,726	$183,512,285
Construction	15,162	$74,937	$1,136,196,966
Transportation/Warehousing	19,746	$64,129	$1,266,300,600
Information	5,985	$63,750	$381,543,471
Professional/Business Svcs	27,875	$61,537	$1,715,333,781
Financial Activities	12,821	$56,821	$728,504,267
Wholesale Trade	6,368	$56,177	$357,732,284
All Industries	**327,987**	**$53,208**	**$17,451,502,959**
Education And Health Services	48,848	$51,002	$2,491,359,372
Manufacturing	13,217	$49,115	$649,152,816
Agriculture, Forestry, Fishing, Hunting	1,151	$48,600	$55,938,034
Retail Trade	36,368	$31,174	$1,133,752,759
Leisure And Hospitality	35,371	$23,627	$835,719,030

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section

Gold mining employment grew 45 percent over the last decade and wages grew 51 percent, mostly from 2009 to 2012 when gold production jumped. (See exhibits 3 and 7.) Nongold metal mining employment grew more gradually, rising 24 percent overall from 2008 to 2017.

Gold mining employment was more volatile and had larger swings, as Exhibit 8 shows, until 2016 when prices stabilized. For other metals, growth has been more gradual but sustained. Only 2014 showed a dip in non-gold mining employment.

Most metal miners are young men, Alaska residents

In 2017, Alaska residents made up 62 percent of all metal mining workers and brought home 64 percent of total wages, with some variation depending on the type of metal. (See Exhibit 9.)

The highest resident percentage was in zinc and lead mining, at 71 percent. This is largely because Alaska's largest zinc mine is Red Dog, which operates under an agreement with NANA Development Corporation, which owns the mine. A substantial portion of Red Dog's workers are resident NANA shareholders.

Support jobs are the exception, at just 39 percent resident. The need for highly specialized workers unavailable locally is often cited for the disparity. These jobs include drilling and boring machine tool setters, specialized earth drillers and extraction workers, and millwrights.

The majority of residents in metal mining are men (88 percent), who earn 91 percent of total wages. Women, at 12 percent of workers, earn 9 percent.

The median age is 37, with 57 percent of workers 40 or younger. Just 26 percent are 50 or older. (See Exhibit 10.)

These demographics are common in the mining industry overall due to remote job sites, extreme conditions, and atypical work schedules such as one week on, one week off.

Interest in metal mining is growing

Interest in mining appears to be growing. From 2016 to 2017, the number of state prospecting sites increased 174 percent while active site claims grew 10 percent and federal claims increased by 11 percent. Overall, the area of new claims staked grew 232 percent in 2017.

According to the Alaska Department of Natural Resources, a prospecting site grants exclusive prospecting rights for two years and exclusive rights to convert the site to a claim upon discovery. A mining claim is a parcel of land in which the claimant has the right to develop and extract a discovered mineral deposit. These claims can be on state or federal land and are subject to applicable regulations.

A range of new projects and new ores are on the horizon

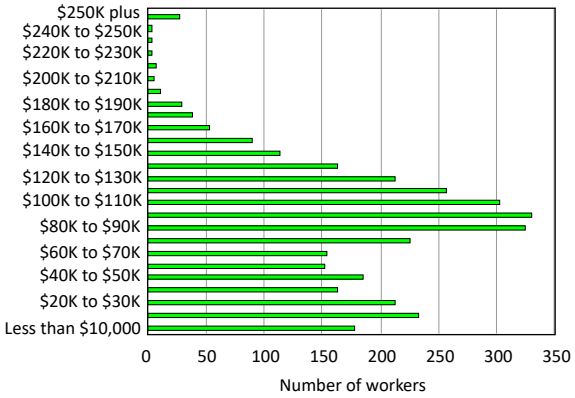
According to the Fraser Institute's Annual Survey of Mining Companies, Alaska ranked fifth out of 91 global regions for mineral potential in 2017 and 10th for overall investment attractiveness by mining and exploration companies. The Department of Labor and Workforce Development projects metal mining employment[1] will grow 18.4 percent from 2016 to 2026.

Alaska has multiple opportunities on the horizon, both in the short and long term. Some mines are expanding or pursuing new developments, such as Kensington Mine's

[1]Does not include support jobs

6 What Metal Miners Earn*

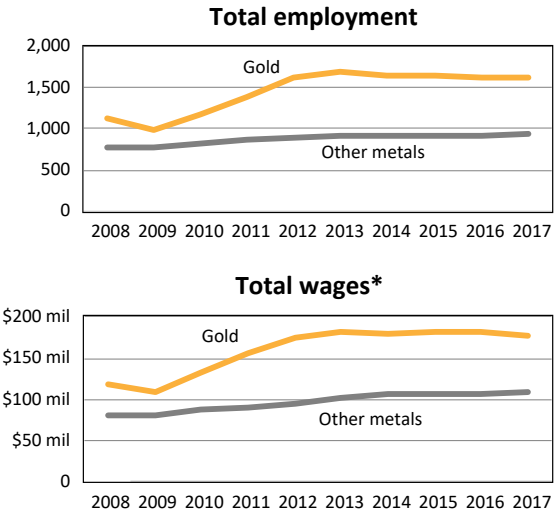
ALASKA, 2017



*Includes wages for all people who worked in metal mining at any time during the year. Workers with lower wages likely worked only part of the year.
Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section

7 Most Jobs, Wages in Gold

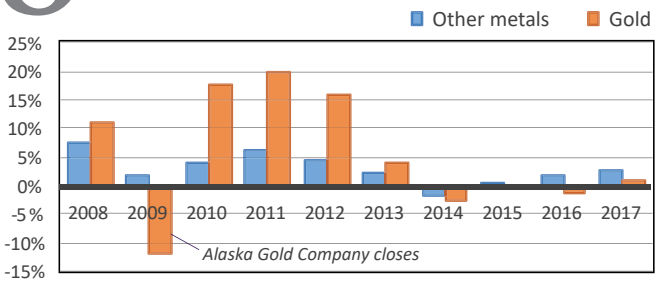
ALASKA, 2008 TO 2017



*Adjusted to 2017 dollars
Note: Does not include support employment and wages
Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section

8 Gold Mining More Volatile

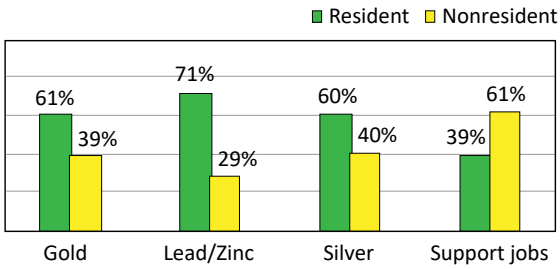
Employment change, 2008 to 2017



Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section

9 Most Miners Are Residents*

Residency by metal mined, 2017



*As defined by PFD eligibility criteria
Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section

Jualin vein, Fort Knox's Gilmore project, and Red Dog's Anarraaq-Aktigiruq project.

Other potential projects include new mines such as the Pebble Project, a poryphyry copper-gold-molybdenum deposit in the Bristol Bay region; Donlin Gold, a proposed, large open pit gold mine in the southwest; and Palmer (copper-zinc-silver-gold-barite). All three are in the advanced exploration stage, although final permitting is uncertain for Pebble in particular due to opposition from groups concerned about possible effects on Alaska's salmon streams.

Some former metal-producing mines aim to restart production, including Nixon Fork Mine (gold) and Niblack (copper-zinc-gold-silver). Mining of copper, which has been produced in Alaska on and off for more than a century, is expected to resume due to rising global demand for copper in the power industry and electric vehicle production.

Finally, while still an emerging market, exploration of rare earth elements shows promise as demand increases due to their use in defense and other modern technology. One such possibility is the Bokan-Dotson Ridge Project, which is in the advanced exploration phase. The project is located on Prince of Wales Island in an area rich in heavy rare earth elements such as dysprosium, terbium, and yttrium.

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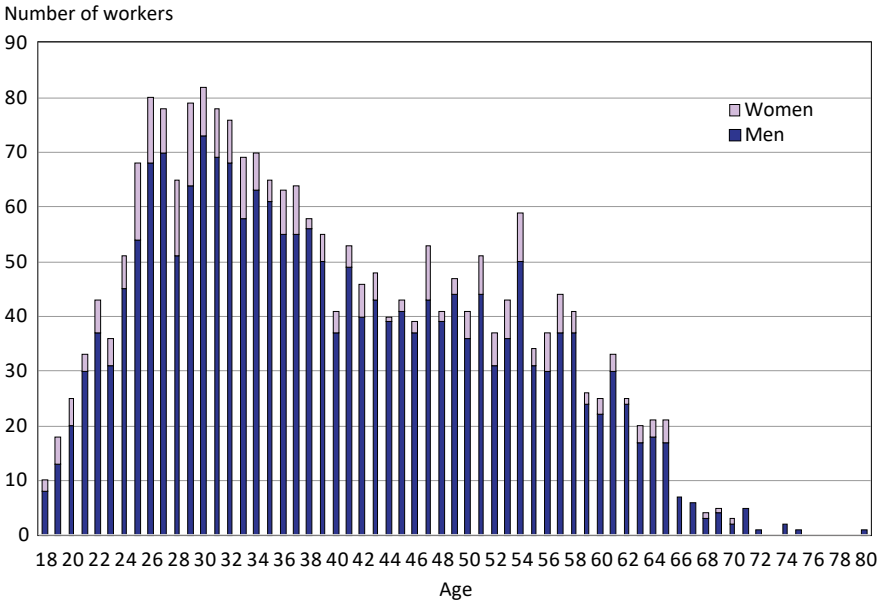
10 Age and Gender Distribution of Workers

Alaska metal mining, 2017



Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section