

INFORMATION SERIES 83

Colorado Mineral and Energy Industry Activities 2019-2020

by Michael K. O'Keeffe and Karen A. Berry



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EXECUTIVE SUMMARY

Several mineral and energy-related commodities are produced in Colorado. In 2019, the top commodities produced in terms of production value include: oil, natural gas, coal, industrial gases (carbon dioxide and helium), gold, molybdenum, cement, sand and gravel, and crushed stone. The estimated total value of mineral and energy fuels production in Colorado for 2019 is \$18.03 billion, slightly lower than the 2018 estimate of \$19.19 billion. Estimated mineral production values for 2019 are shown by commodity type in **Figure ES-1**. Oil and natural gas production accounted for ~84.4% of Colorado's total mineral and energy production value in 2019. Estimated mineral and energy production values for 1994 through 2019 are shown in **Figure ES-2**.

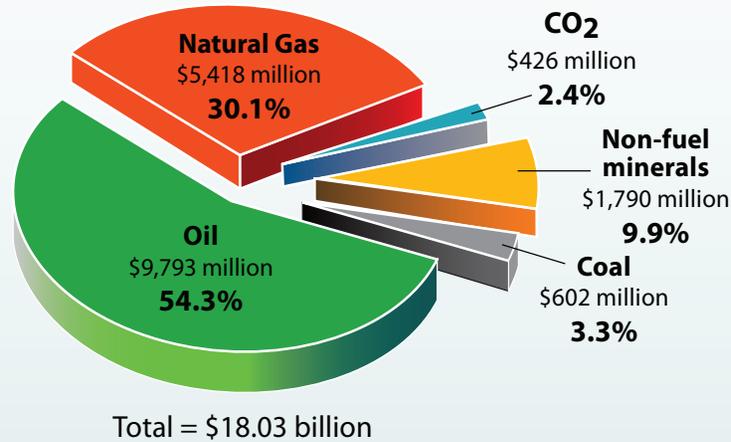


Figure ES-1. Colorado mineral production value by commodity type (U. S. dollars).

The total estimated value of Colorado oil and natural gas production in 2019 is \$15.21 billion. Oil and natural gas production remains higher than historical values and production values have increased from 2016 due to slightly higher prices and an increase in demand. Colorado has the sixth largest proven natural gas reserves and eighth largest proven oil reserves in the U.S. (EIA, 2020a; EIA, 2020b). The estimated value of Colorado coal production in 2019 is \$602 million. The overall decreasing trend in coal production is due primarily to the increased use of natural gas and renewable energy resources nationwide. Colorado dropped from the 11th largest coal producer in the U.S. in 2018 to the 13th largest producer in 2019 (EIA, 2020c) with both underground and surface mines currently in operation west of the continental divide.

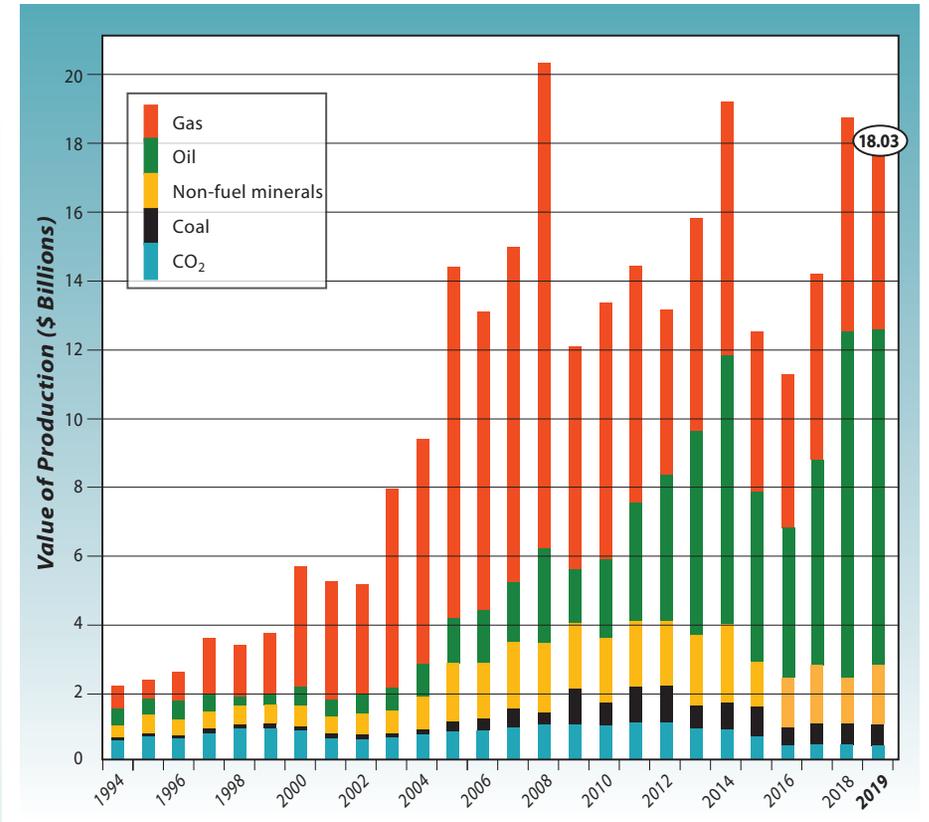


Figure ES-2. Mineral and energy fuel production value in Colorado, 1994–2019.

Non-fuel mineral production includes metals, aggregate (e.g., sand and gravel, crushed stone), and industrial minerals (gypsum, nahcolite) and gases (carbon dioxide, helium). The total value of Colorado's production of non-fuel minerals in 2019 is \$1.79 billion (USGS, 2020a). Colorado is the third largest gold producer in the U.S., behind Nevada and Alaska, based on the total 2019 production from a single mine. Two Colorado mines continue to produce molybdenum and the state was the second largest producer of this metal in 2019 behind Arizona. Molybdenum is produced as a by-product during copper mining in Arizona. Although Colorado has been a producer in the past, there was no uranium mining in Colorado in 2019. Continued low uranium prices account for the lack of mining, however, several property leases and exploration activities continued in 2019 and 2020.

Carbon dioxide produced in Colorado is used primarily for enhanced oil recovery in the Permian Basin oil fields of Texas and New Mexico. The production value estimate for 2019 is \$426 million. Helium is produced in Cheyenne County and other areas in Colorado, however, production estimates from these facilities are not available.

Severance taxes are state taxes collected on companies who produce nonrenewable resources including oil, gas, coal, molybdenum, and gold. Companies that extract these resources pay severance tax as well as other taxes including income, sales, and property taxes. A portion of the severance tax funds is distributed to counties, municipalities, and school districts. Severance tax funds are also used to support the Colorado Geological Survey (CGS) and other programs within the Colorado Department of Natural Resources (DNR). The distribution hierarchy of total collected state severance tax revenue is shown in **Figure ES-3**.

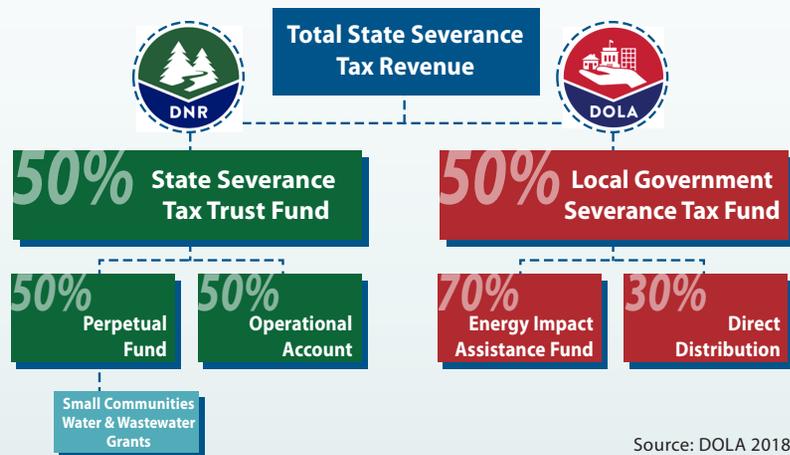


Figure ES-3. Distribution of state severance tax revenue in Colorado.

The Colorado Department of Local Affairs (DOLA) administers the distribution of severance tax revenue to county and local governments. In fiscal year (FY) 2018/2019 (18/19), July 1st through June 30th, Colorado collected \$217.9 million in severance taxes. **Figure ES-4** shows the annual severance taxes collected since 1994. Low levels of severance tax collections during FY 16/17 were caused by several factors including the ad valorem tax credit and amended tax returns filed in response to a 2016 Colorado Supreme Court ruling. These factors are discussed in a previous mineral and energy activities report (O’Keeffe and others, 2018). The map in **Figure ES-5** shows the distribution of severance taxes to each county.

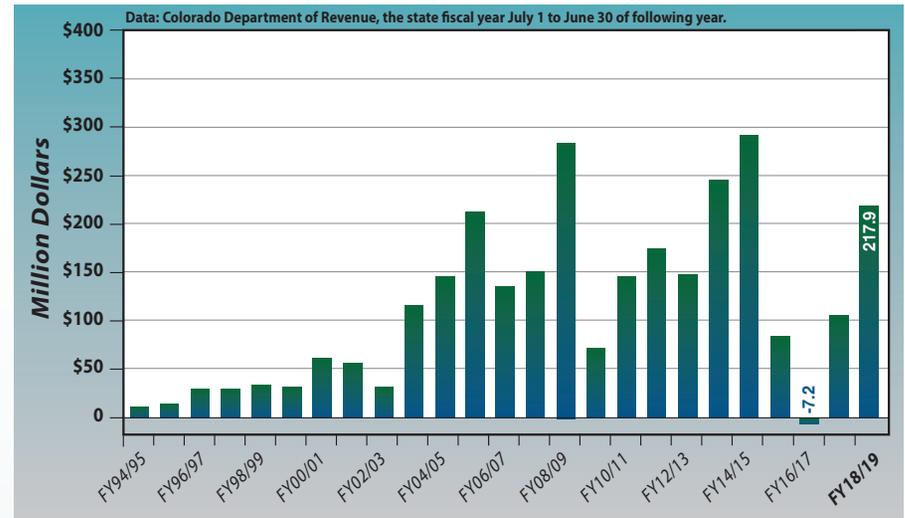


Figure ES-4. Colorado net severance tax collections FY94/95-FY18/19 (NOTE: In FY16/17, severance refunds exceeded collections, hence the negative value).

The State of Colorado owns 2.8 million surface acres and over 4 million mineral estate acres, which are managed by the Colorado State Land Board (SLB). Leasing and royalty revenue from mineral and energy fuel activities on these lands are deposited into the state’s Public School Permanent Fund, which was created to help finance public primary education. Funds collected are distributed through the School Finance Act to school districts on a per student basis. A portion of the SLB revenue also goes to the Department of Education’s Building Excellent Schools Today (BEST) which is a capital construction program that awards grants to schools. In FY 18/19, the SLB received \$124.8 million in mineral revenue (SLB, 2020). The revenues consisted of the following: oil and natural gas royalties and rentals, \$114.3 million; coal, \$5.5 million; minerals, \$1.8 million; and other revenues, \$3.2 million (SLB, 2020). **Figure ES-6** shows the SLB revenues from FY 96/97 to FY18/19.

Lands owned by the federal government constitute over 35% of Colorado’s acreage. The State of Colorado receives 49% of the rental, royalty, and bonus revenue from mineral and energy fuel leases on federal land. This includes bonus, rents, royalties, and other revenue associated with oil, gas, coal, oil shale, geothermal, and sodium (nahcolite) federal leases in Colorado. DOLA distributes a portion of these funds to local governments affected by mineral and energy development. In 2019, federal mineral lease revenues generated totaled ~\$230.2 million with ~\$108 million disbursed back to the state (U.S. Department of Revenue [USDR], 2020). **Figure ES-7** shows the revenue from federal mineral leases from 2009 to 2019.

Severance Tax Distribution by County

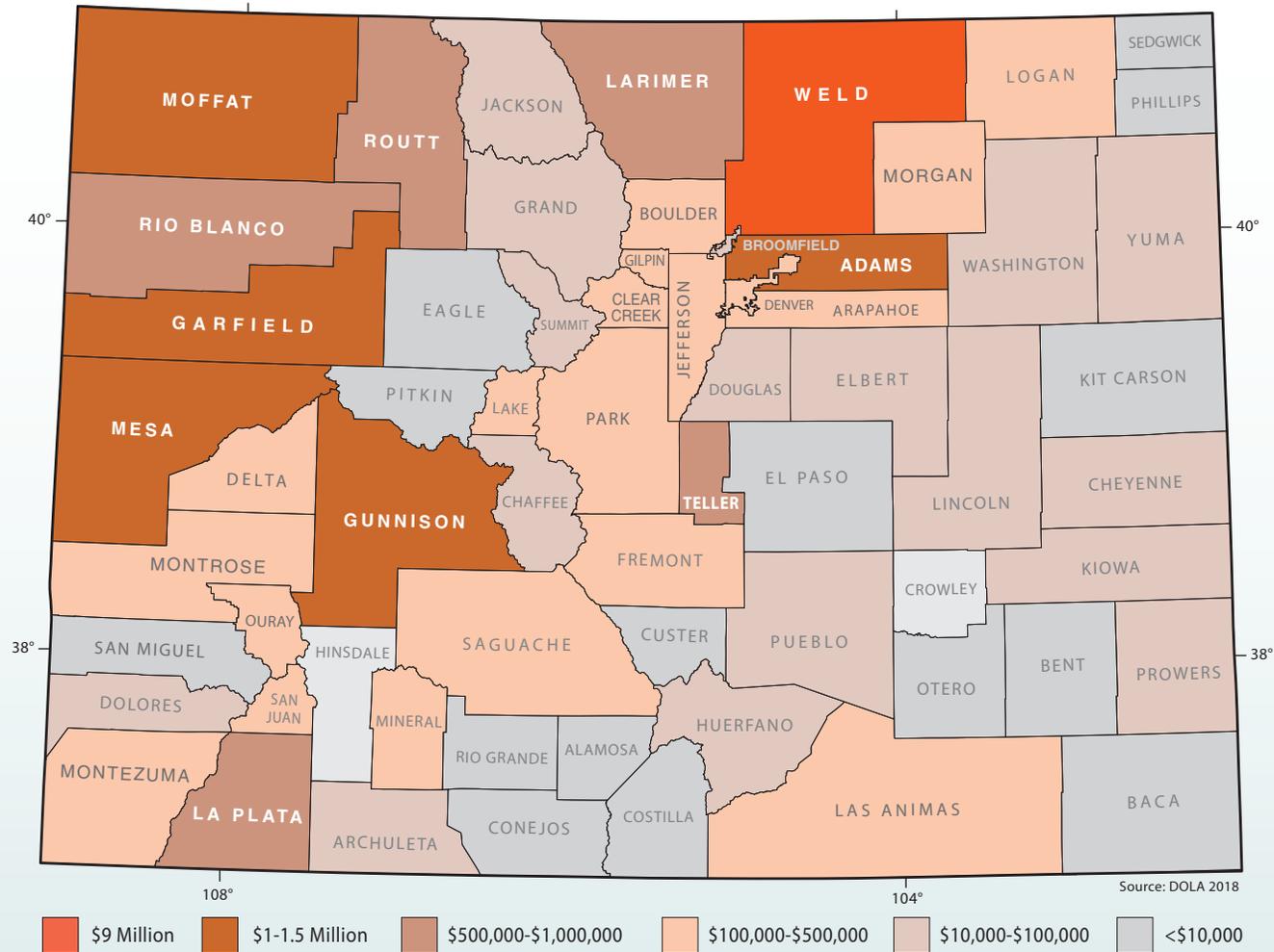


Figure ES-5. Colorado Mineral Severance Tax Distributions by County, FY 19/20.

On March 11, 2020, the World Health Organization (WHO) declared the novel coronavirus (COVID-19) a global pandemic (Cucinotta and Vanelli, 2020). The long-term impact of the global pandemic on commodities generated in Colorado has yet to be determined. When compared to the 2019 production data presented in this report, preliminary estimates indicate that the 2020 production of coal, oil, natural gas, and molybdenum (based on the first 9 months of molybdenum production data) in Colorado have decreased by about -24%, -17%, -6.8%, and -21%, respectively (DRMS, 2020a; COGCC, 2020a; Freeport, 2020a). Colorado

gold production from Cripple Creek & Victor, the only major gold mine in Colorado, has decreased by about -15% based on the first 9 months of data, however, this decrease is reportedly due to other factors such as leach recovery timing and lower grades milled (Newmont, 2020a). Commodity production, value, and severance taxes generated during 2020 will be included in the next version of this report.

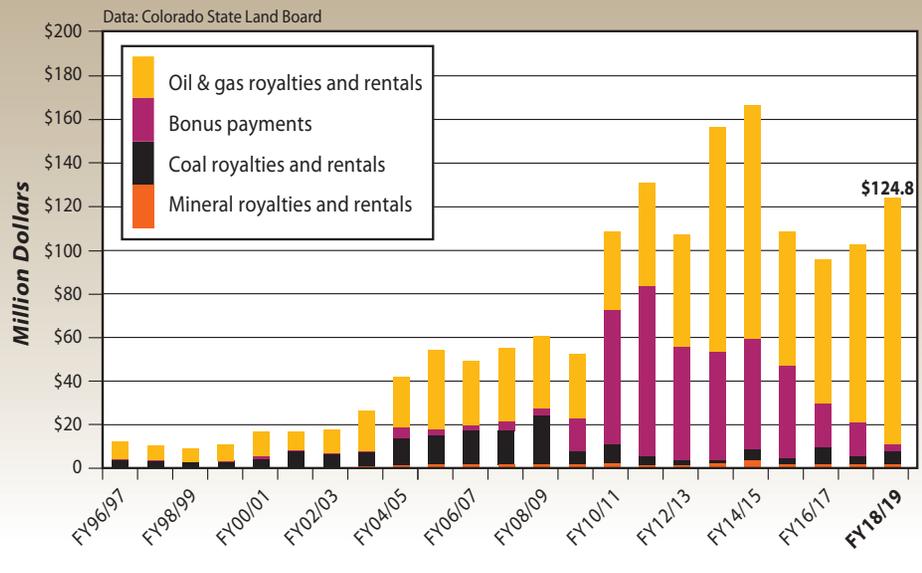


Figure ES-6. Colorado State Land Board (SLB) mineral revenues.

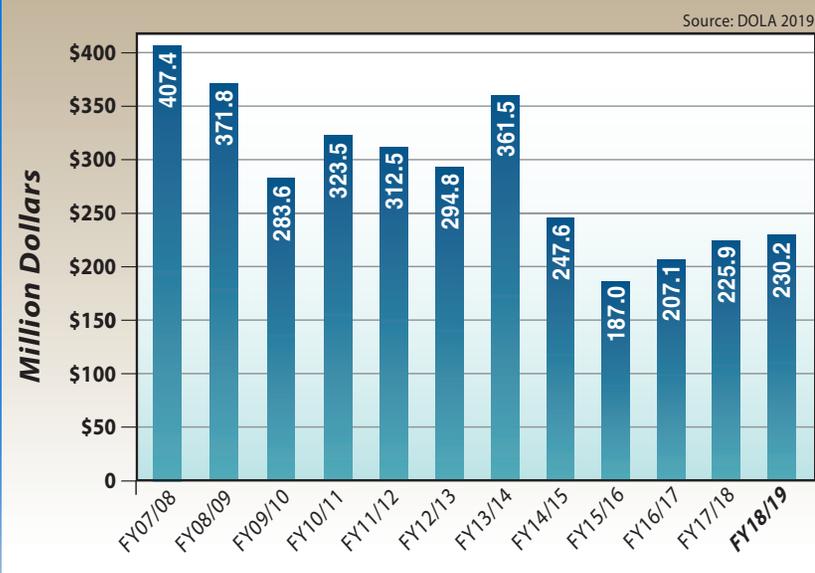


Figure ES-7. Federal mineral lease revenue generated in Colorado.



Well operations, southeast of Grover, Weld County

CONVENTIONAL ENERGY RESOURCES

Oil and Gas

The map in **Figure 1** shows the major sedimentary basins in Colorado and the location of 2019 oil and natural gas approved drilling permits. Most of the drilling activity and production increases in the last few years are in unconventional reservoirs, especially in the Denver-Julesburg (DJ) Basin of northeastern Colorado. According to the U.S. Department of Energy (DOE) Energy Information Agency (EIA), ~63% of total U.S. crude oil production in 2019 was from tight oil formations (EIA, 2020d). Hydraulic fracturing and horizontal drilling techniques have allowed these unconventional reservoirs to be produced at a relatively low cost.

Average annual oil prices decreased in 2019 to \$50.89 per barrel (EIA Colorado Domestic Crude Oil First Purchase Price) from an average of \$59.87 in 2018 (EIA, 2020e). Using this price and the Colorado Oil and Gas Commission (COGCC) production estimate (COGCC, 2020a), the estimated overall oil production value in 2019 for Colorado is \$9.793 billion (**Figure 2**). This total value is the second highest on record (last year was the highest on record) and is due to an increase

Oil & Gas Well Drilling Permits in Colorado

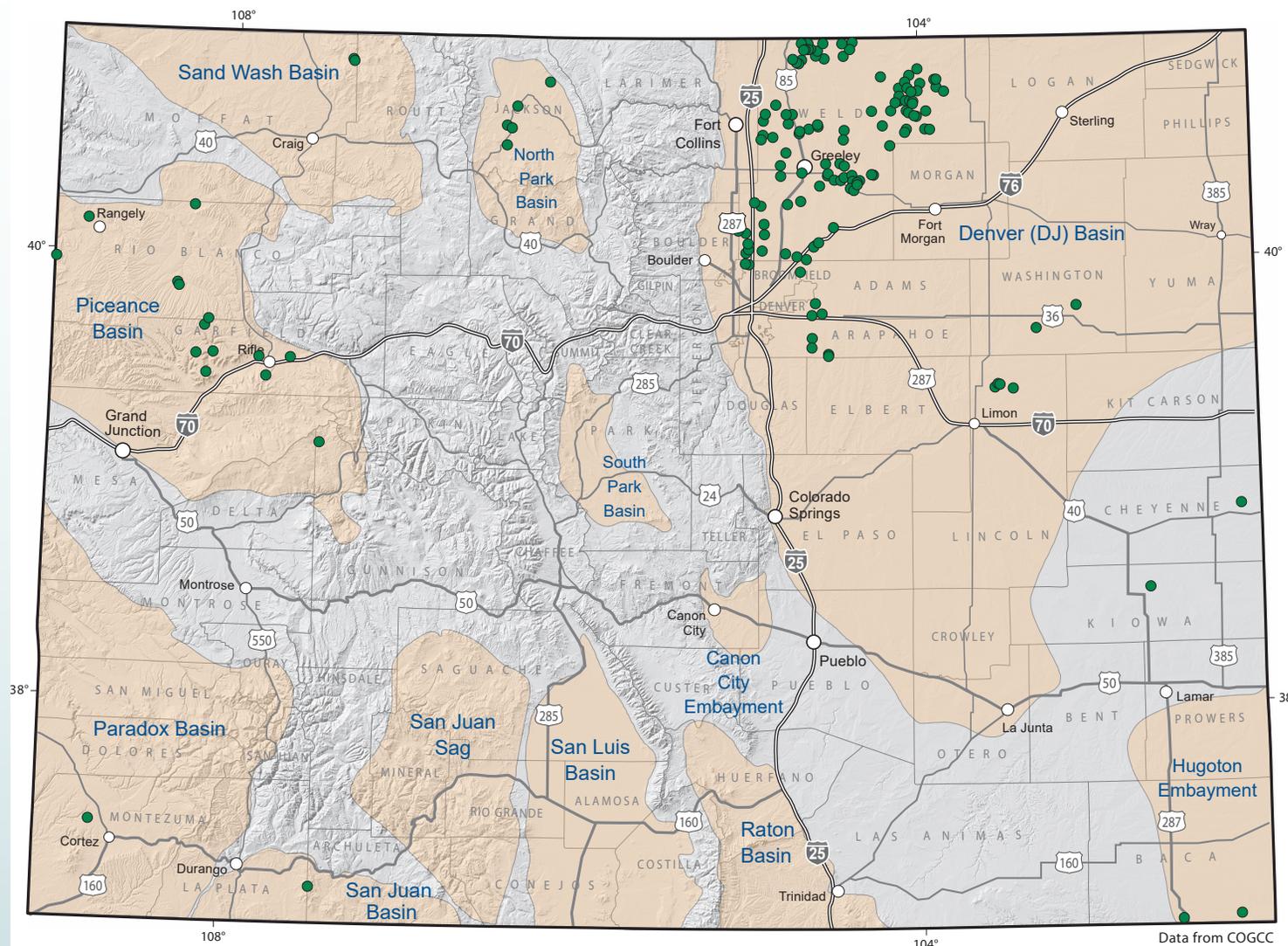


Figure 1. Sedimentary basins and the location of oil and gas well drilling permits (green dots) from January 2019 to December 2019.

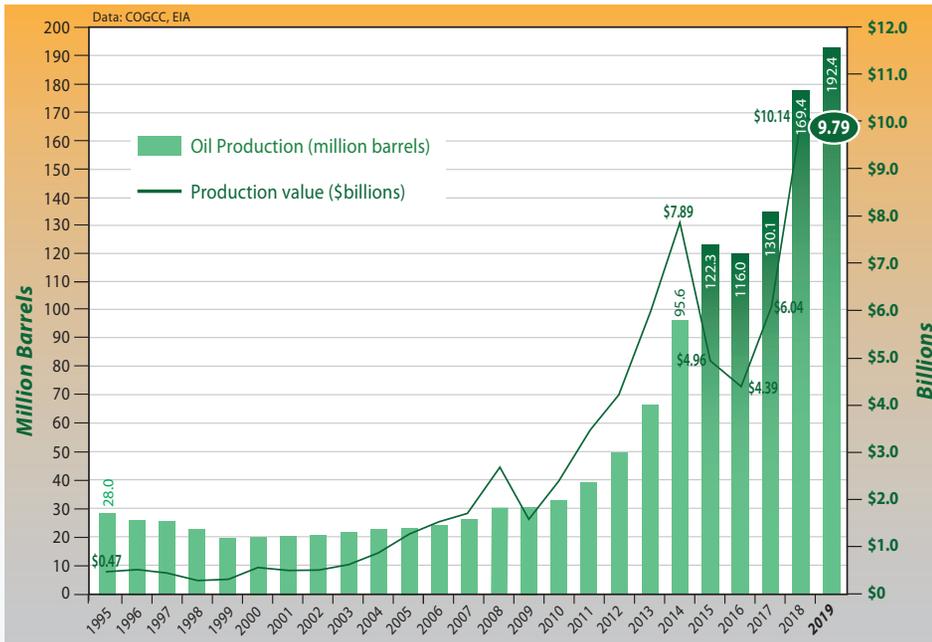


Figure 2. Oil production and estimated production value in Colorado, 1995–2019.

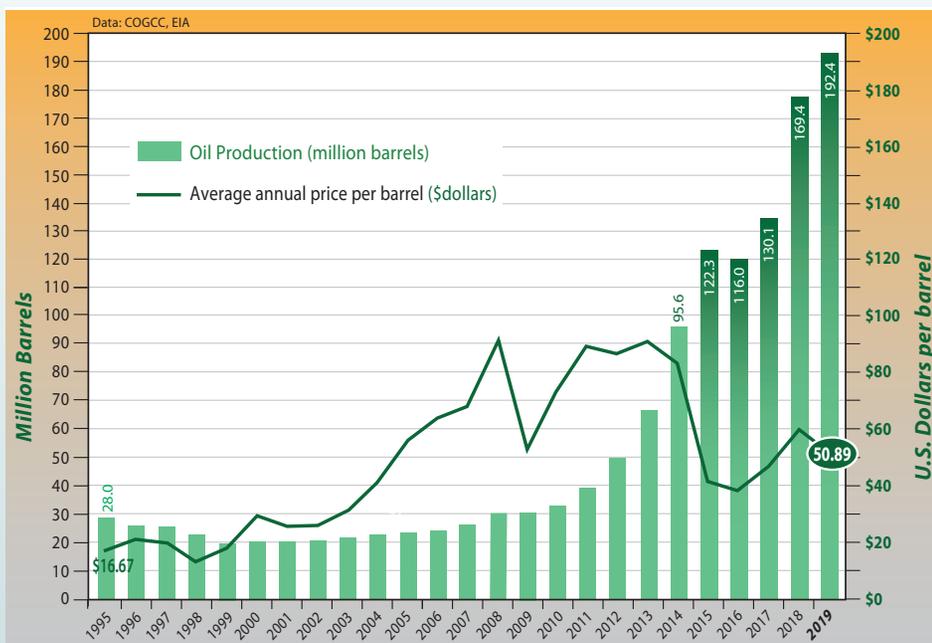


Figure 3. Colorado oil production and average annual price per barrel, 1995–2019.

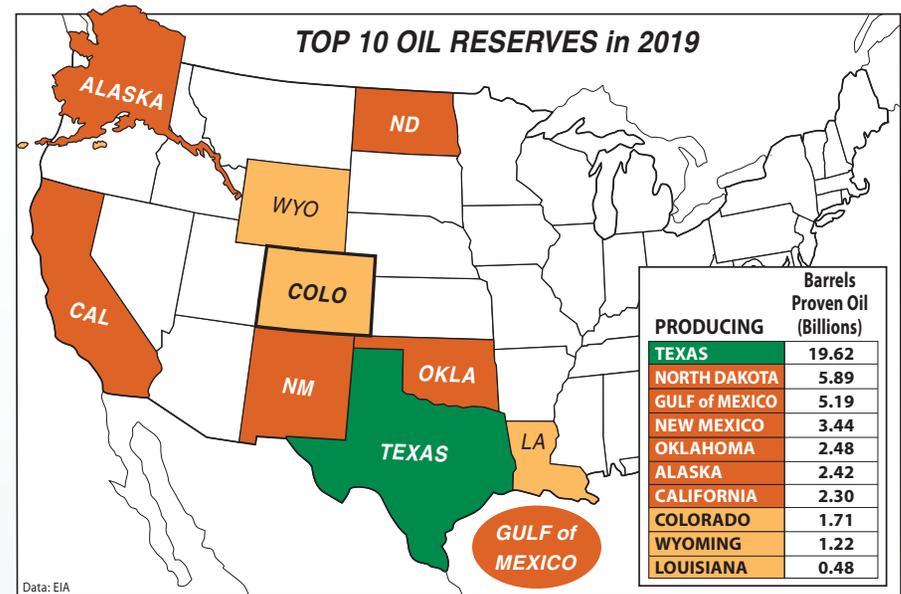


Figure 4. Top 10 states with proven oil reserves in 2019.

in production. Estimated oil production in Colorado between 2018 and 2019 increased by over 20,000 barrels to ~192.4 million barrels. Oil production in Colorado and the average annual price per barrel over time are shown in Figure 3.

At the end of 2019, Colorado ranked eighth among the top ten states with proven oil reserves with an estimated 1.711 billion barrels of oil (BO) (EIA, 2020f) (Figure 4).

The 2019 average spot price for natural gas was \$2.66 per thousand cubic feet (Mcf) (based on a heat content of 1.037 British Thermal Units per Mcf) (EIA, 2020g) (Figure 5). U.S. natural gas production generally increased between 2008 and 2019 which is consistent with the general decrease in price. Colorado's natural gas production increased from ~1,902 billion cubic feet (Bcf) in 2018 to ~2,035 Bcf in 2019. The estimated total 2019 natural gas production value in Colorado, using the Henry Hub spot price and COGCC production data (COGCC, 2020a), is \$5.42 billion. In 2018, Colorado had proven natural gas resources of 26,132 Bcf, which was the sixth largest in the U.S. (EIA, 2020h) (Figure 6).

As presented in previous CGS Mineral and Energy Industry Activity (MEIA) reports, the U.S. Geological Survey (USGS) released an updated 2016 Mancos Shale oil and gas potential assessment for the Piceance Basin located in central and northwestern Colorado (USGS, 2016a). This study assessed undiscovered

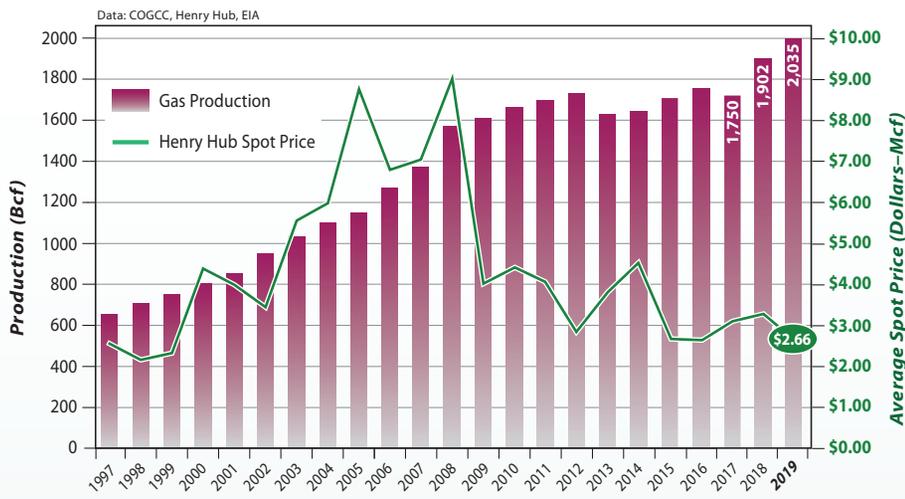


Figure 5. Colorado natural gas production and average price, 1997-2019.

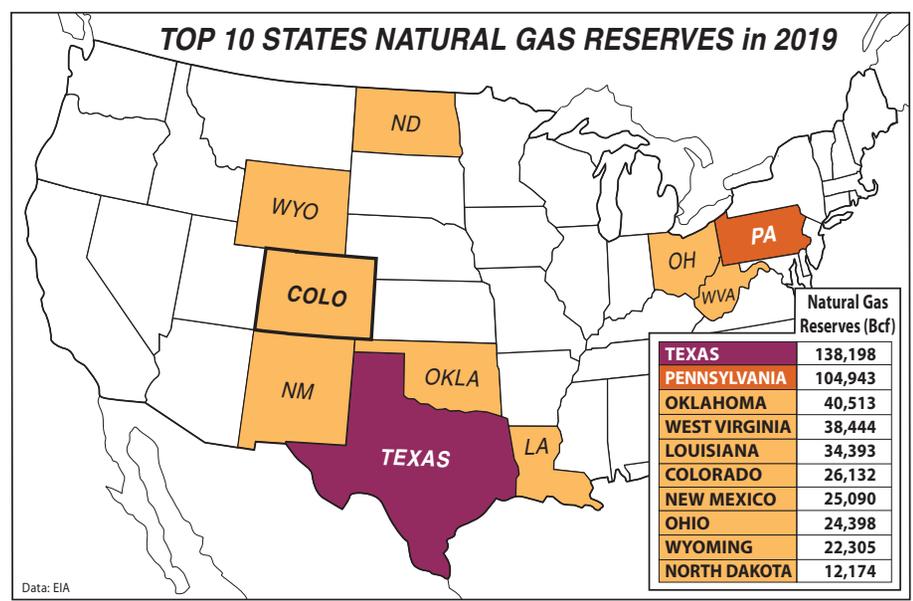


Figure 6. Top 10 states with proven natural gas reserves in 2019 (years end).

and technically recoverable resources in the Late Cretaceous Mancos Shale. The report states that the Mancos Shale within the Piceance Basin contains 66.3 trillion cubic feet (Tcf) of natural gas, 74 million BO, and 45 million barrels of natural gas liquids (USGS, 2016a). In 2018, the House Natural Resources Committee held a hearing to discuss the possibility of exporting natural gas from the Piceance Basin through the proposed Jordan Cove LNG Terminal and Pacific Connector Gas Pipeline. This project would connect the resources from the Piceance Basin via pipeline to international markets through a proposed liquefied natural gas (LNG) export terminal in Oregon. In 2020, the Federal Energy Regulatory Commission authorized the construction of the Jordan Cove LNG Terminal in Oregon and the related Pacific Connector Gas Pipeline (DOE, 2020a), which, if built, would transport natural gas from Colorado to the terminal and overseas markets.

Coalbed Methane

Figure 7 shows Colorado’s annual coalbed methane production versus conventional natural gas over time. Coalbed methane production reached its highest levels, 59%, of all natural gas production during 1998. Production has continuously declined to ~12% of all natural gas production (253 Bcf) in 2019 (COGCC, 2020a). This decline is largely due to the increase of natural gas production of unconventional reservoirs by the utilization of horizontal drilling and hydraulic fracturing techniques.

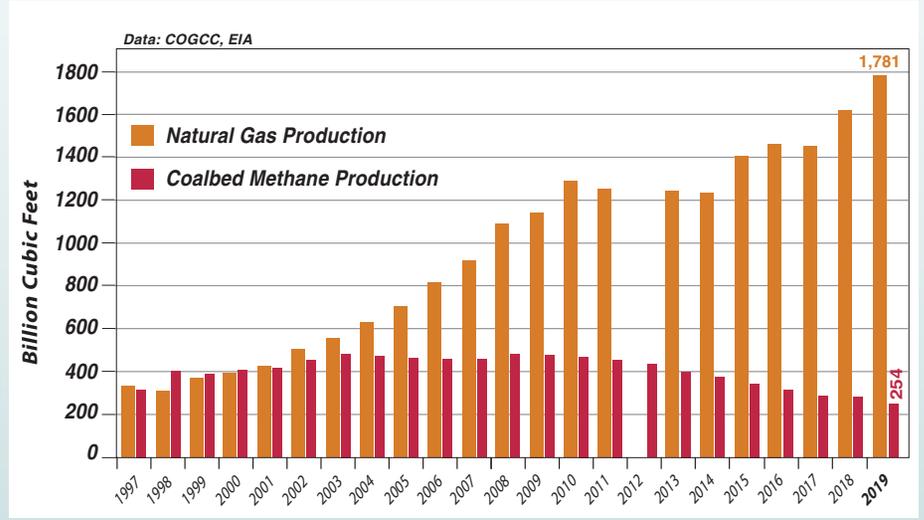
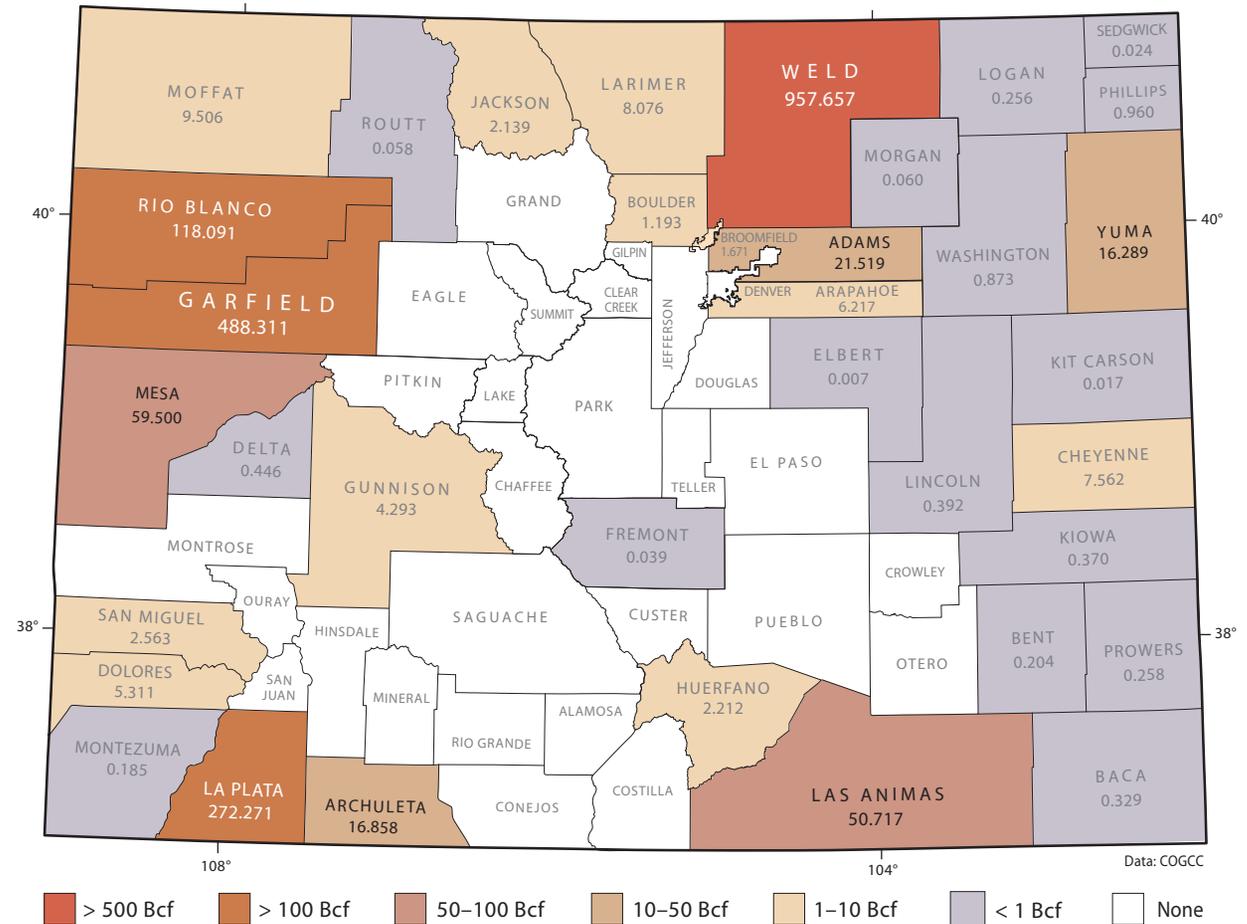


Figure 7. Coalbed methane vs. non-coalbed natural gas production in Colorado, 1997-2019.

COGCC Regulations

As reported in the last MEIA report (O’Keeffe and Berry, 2019), Senate Bill (SB) 19-181 was passed in 2019 which required the COGCC to place more emphasis on public and environmental health and safety and addressing cumulative impacts from oil and gas activities. Additionally, the new law shifts the agency’s mission from “fostering” the responsible development of oil and gas resources to “regulating” oil and gas development “in a manner that protects public health, safety, welfare, the environment and wildlife resources” (COGCC, 2020c). During 2019 and 2020, the COGCC worked on rule and policy changes associated with implementing SB19-181. This included several rule making hearings in 2020, which included public comments and testimonies, associated with changes to the COGCC regulations to meet SB19-181. In late 2020, the COGCC adopted these new rules which will become effective in January 2021. Additionally rule making hearings will be completed in 2021. The COGCC provides the details and summary documents on the rule making hearings and rule/policy changes on their website (<https://cogcc.state.co.us/#/home>) (COGCC, 2020c).

2019 Natural Gas Production (bcf) by County



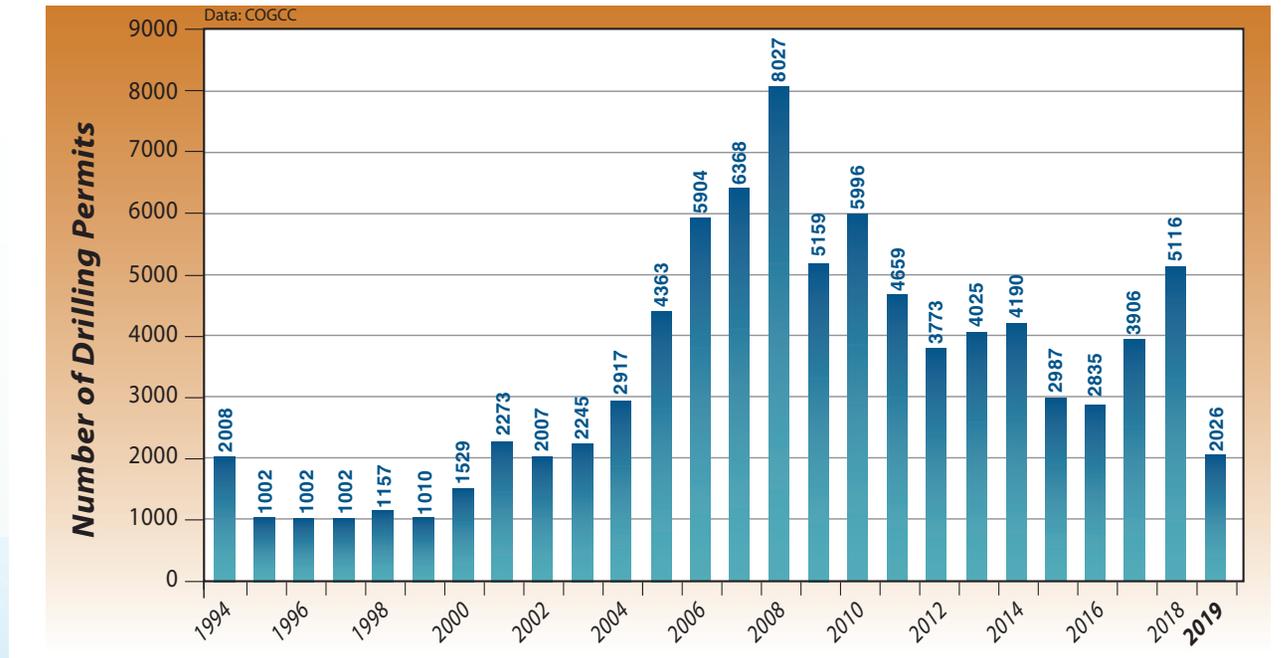


Figure 11. Annual oil and gas drilling permits in Colorado, 1994-2019.



CONVENTIONAL ENERGY RESOURCES: COAL

Coal production in the U.S. decreased 6.6% in 2019 compared to 2018 (EIA, 2020c). However, coal continues to be a major source of the state's electrical power. According to the EIA, 45% of the electricity generated in Colorado in 2019 came from coal-fired power plants (EIA, 2020i). In 2019, 25% of electric generation in Colorado was from renewable sources especially wind and solar power (EIA, 2020i). For comparison, in 2015, 60% of the electricity generated in Colorado came from coal indicating a move away from energy production from coal. As reported in previous MEIA reports, the decline of the use of coal for electricity generation is due to lower natural gas prices, federal greenhouse gas regulations and taxes designed to cut carbon dioxide emissions, and the declining costs and growing use of renewable energy sources.

Between 2010 and 2019, more than 546 coal-fired power units were retired in the U.S. totaling ~102 gigawatts (GW - one billion watts) of generating capacity (EIA, 2020j). An additional 25 GW associated with coal-fired power units is expected to shut down by 2025 (EIA, 2020k). For comparison, at the end of 2019, the U.S. had ~1,101 GW of total utility-scale electricity generating capacity (EIA, 2020l). U.S. annual coal-fired unit retirements were the highest in 2015 and second highest in 2018 (EIA, 2020j). In 2019, carbon dioxide emissions associated with coal-fired power plants reportedly decreased by 14.6% which is the largest annual fuel emission decrease in the EIA's annual carbon dioxide data series dating back to 1973 (EIA, 2020m). As of 2019, U.S. carbon dioxide emissions from motor gasoline exceeded coal (EIA, 2020m).

In 2010, Colorado passed the Clean Air, Clean Jobs Act which promotes the replacement of Front Range coal-fired power plants with natural gas plants. Between 2012 and 2013, utility companies shut down the Arapahoe Station in Denver, the Clark Plant in Cañon City, and the Cameo power plant near Grand Junction. In 2017, Xcel Energy (Xcel) converted the last remaining coal-fired unit at Cherokee Generating Station in Denver to natural gas and announced they would close two of three coal-burning units at the Comanche Generation Station in Pueblo between ~2022 (Unit 1) and 2025 (Unit 2) (Denver Post, 2017). In 2019, The Tri-State Generation and Transmission Association officially retired the 100-megawatt Nucla Station power plant. In 2020, the Craig Generating Station in Moffat County announced it would close coal-fired units 1, 2, and 3 by 2025, 2028, and 2030, respectively (IEA, 2020). In early 2021, Xcel Energy announced that Hayden Generating Station in Moffat County would close coal-fired Unit 1 by the end of 2028 and Unit 2 by the end of 2027 (Colorado Sun, 2021).

Table 1. Coal production, price, value, and employment, 2002–2019.

About half of the coal mined in Colorado is used for power generation within the state while some of the coal is transported to about twenty other states for use in electric power generation or by industrial plants. Almost 25% of Colorado's mined coal is exported to other countries (EIA, 2020n). Colorado has some of the cleanest burning coal in the U.S. and previous MEIA reports include summary information about Colorado's coal quality compared to other regions. Coal production from Colorado mines in 2019 is 13.63 million tons (DRMS, 2020a). The estimated value of Colorado coal production in 2019 is \$602 million (**Table 1** and **Figure 12**) and the estimated average value of a ton of Colorado coal was \$44.21 (EIA, 2020c). Colorado coal production and average prices since 2004 are shown in **Figure 13**. In 2019, six Colorado coal mines were active (**Table 2**) employing 1,098 coal miners (DRMS, 2020a) (**Figure 14**). In 2019, Colorado was ranked 13th in coal production in the U.S. (**Figure 15**) down from 11th in 2018 (EIA, 2020c). Wyoming, the leading U.S. producer by far, mined over 20 times as much coal as Colorado. The locations of Colorado's active coal mines, coal-fired power plants, coal types and regions, and estimated coal-fired closing dates are shown on **Figure 16**.

Year	Production Tons (Millions)	Colorado Average Annual Coal Price \$/Ton	Product Value (Millions)	Coal Miner Employment
2002	35.20	\$17.72	\$624	1,854
2003	35.88	\$18.21	\$653	1,859
2004	39.81	\$18.10	\$721	1,903
2005	37.82	\$21.63	\$818	1,963
2006	35.49	\$24.27	\$861	2,065
2007	36.14	\$25.99	\$939	2,069
2008	32.34	\$32.67	\$1056	2,124
2009	28.58	\$36.71	\$1049	2,247
2010	25.21	\$40.00	\$1008	2,061
2011	27.03	\$39.88	\$1078	2,254
2012	28.64	\$37.54	\$1075	2,279
2013	24.27	\$37.58	\$912	1,857
2014	22.98	\$38.64	\$888	1,512
2015	18.73	\$36.12	\$676	1,326
2016	12.80	\$42.54	\$499	1,211
2017	15.18	\$42.52	\$645	1,119
2018	14.28	\$43.30	\$618	1,160
2019	13.63	\$44.21	\$602	1,098

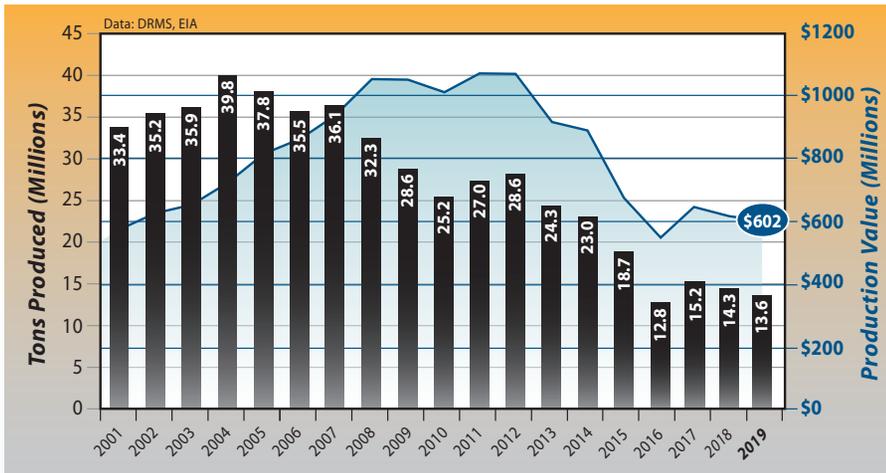


Figure 12. Production and value of coal mined in Colorado, 2001–2019.

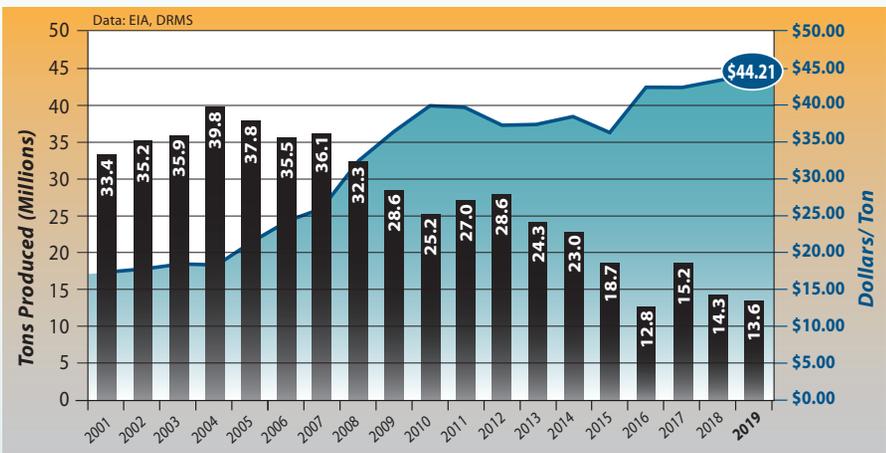


Figure 13. Coal production and average annual coal price in Colorado, 2001–2019.

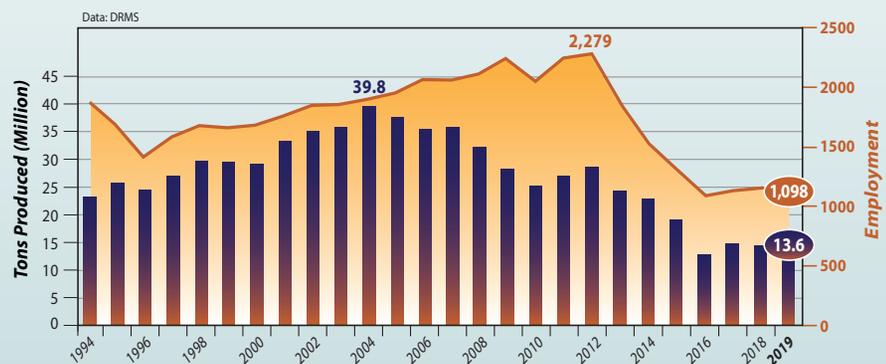


Figure 14. Coal production and employment in Colorado, 1994–2019.

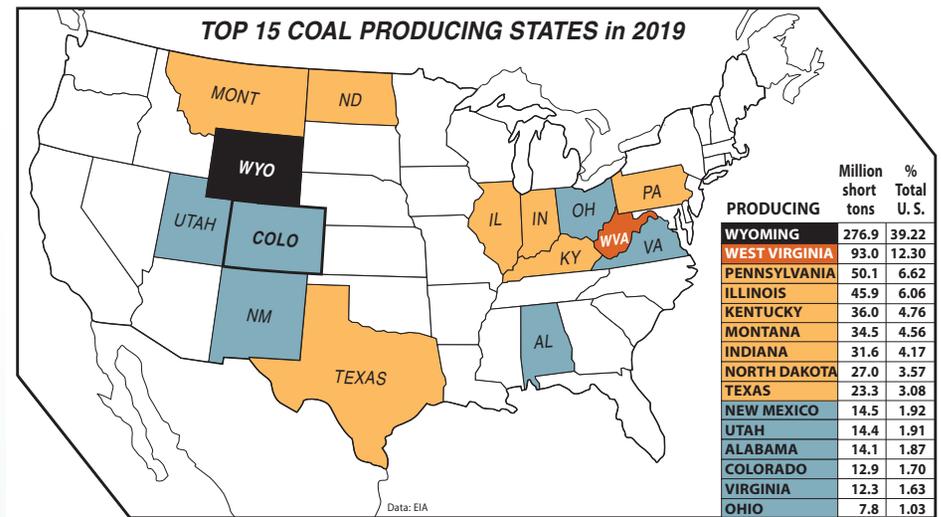


Figure 15. Top 15 coal-producing states in 2019.

In 2018, Colowyo Mine in Moffat County was preparing to start mining operations at their expansion project, the Collom Pit, which would extend the mine life over 30 years. However, in early 2021, the owners of the mine, Tri-State Generation and Transmission Association, announced that the Colowyo Mine is expected to cease coal production by 2030 (Herald Times, 2021). In early 2019, the U.S. Office of Surface Mining Reclamation and Enforcement (OSMRE) approved expansion of the West Elk Mine located in Gunnison County; however, a federal judge recently blocked the expansion due to lawsuits. In 2020, expansion of the King II Mine located in La Plata County was approved by the U.S. Bureau

Table 2. Active coal mines in Colorado, 2019.

Mine	Operator	County	Mine Type	2019 Prod. (tons)
Bowie #2	Bowie Resources Ltd.	Delta	Underground	shut down
Colowyo	Colowyo Coal Co. L.P.	Moffat	Surface	1,597,967
Deserado	Blue Mountain Energy	Rio Blanco	Underground	2,716,129
Foidel Creek	Twentymile Coal Co./Peabody Energy	Routt	Underground	2,543,911
King II	GCC Energy LLC	La Plata	Underground	657,782
Trapper Strip	Trapper Mining Inc.	Moffat	Surface	1,954,282
West Elk	Mountain Coal Co./Arch Coal	Gunnison	Underground	4,157,835
Total				13,627,924

Data: DRMS

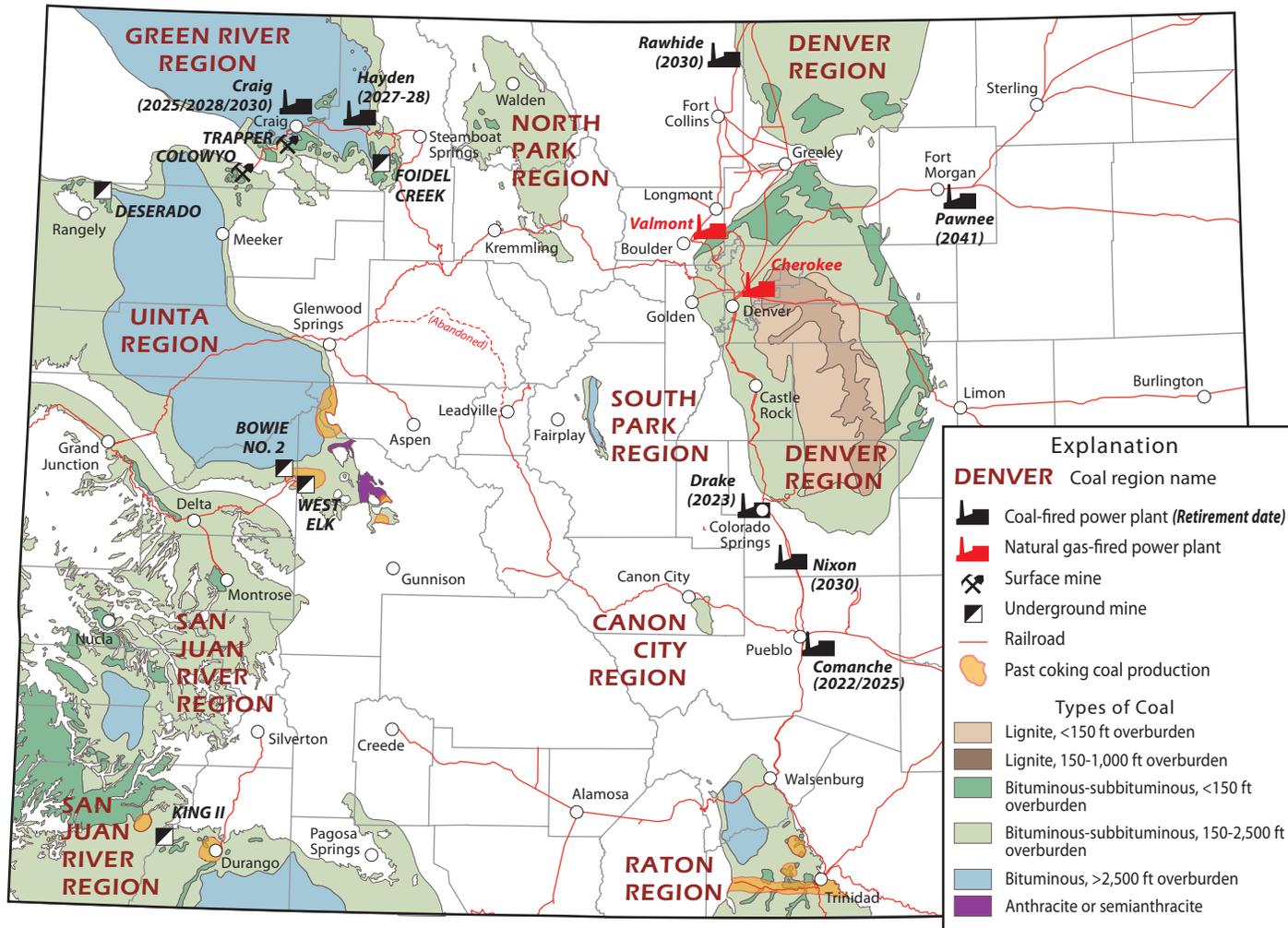


Figure 16. Locations of active coal mines, power plants, railroads, and coal-bearing regions in Colorado, 2019. Dates in parenthesis are estimated retirement dates for coal-burning units.

of Land Management (BLM) and is awaiting final approval from the U.S. Office of Surface Mining, Reclamation and Enforcement (Durango Herald, 2020). The expansion would extend the life of the mine by 20 years, however, a lawsuit filed by conservation groups against the U.S. Department of Interior may halt the expansion due to environmental concerns (Durango Herald, 2020).

CONVENTIONAL ENERGY RESOURCES: URANIUM

Nuclear energy accounted for 19.6% of U.S. electricity production in 2019 (EIA, 2020o). Colorado is one of about twenty states that did not generate electricity from nuclear energy. At the time of this report, there are 58 nuclear power plants with 96 nuclear reactors operating in 29 states. Two new nuclear reactors are currently under construction in Georgia and are expected to come online between 2021 and 2022 (EIA, 2020p).

Figure 17 shows the average annual uranium prices in the U.S. over time. As reported last year, prices have been generally trending downward since 2007 and after the 2011 Fukushima nuclear power plant accident in Japan. **Figure 18** shows the estimated annual production of uranium concentrate in the U.S. between 1996 and 2019. Although Colorado has been a producer of uranium in the past, there are currently no producing uranium mines or mills in Colorado. The proposed Pinon Ridge uranium mill located in Montrose County is on hiatus due to a 2018 court ruling (CDPHE, 2020). Uranium concentrate production from U.S. mines in 2019 was the lowest recorded since 1949 (EIA, 2020q; EIA, 2020r). In 2019, U.S. uranium concentrate was produced from five in-situ leaching facilities, four in Wyoming and one in Nebraska, and one underground mine (EIA, 2020q).

In 2018, the U.S. Department of the Interior (DOI) listed uranium as a critical mineral. DOI defined a critical mineral as a non-fuel mineral or mineral material essential to the economic and national security of the U.S., the supply chain of which is vulnerable to disruption and, that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security (Fortier and others, 2018). In 2019, over 90% of uranium purchased and delivered to U.S. civilian nuclear power reactors came from other countries including: Canada (21%), Kazakhstan (18%), Australia (18%), Russia (15%), Uzbekistan (9%), and Namibia (5%) (EIA, 2020s). In July 2019, a presidential memorandum ordered the establishment of the U.S. Nuclear Fuel Working Group (NFWG) “to develop recommendations for reviving and expanding domestic nuclear fuel production” (U.S. White House, 2019). In 2020, the NFWG announced a nuclear energy strategy that included strengthening the U.S. uranium mining and conversion industries (DOE, 2020b). In early 2019, a federal judge lifted a ban on some uranium leases in southwest Colorado and the DOE Office of Legacy Management (DOE LM) restarted their uranium leasing program on uranium-rich public lands as it did in 2008. This program leases properties in the Uravan Mineral Belt area, a

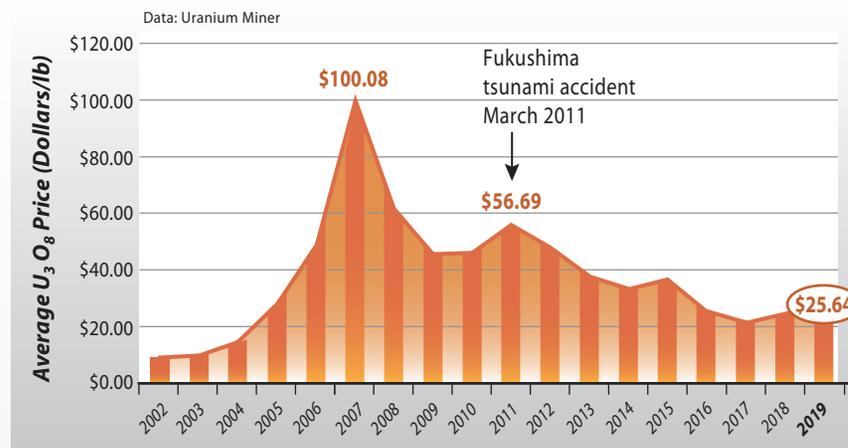


Figure 17. Average annual U₃O₈ price per pound in U. S., 2002–2019.

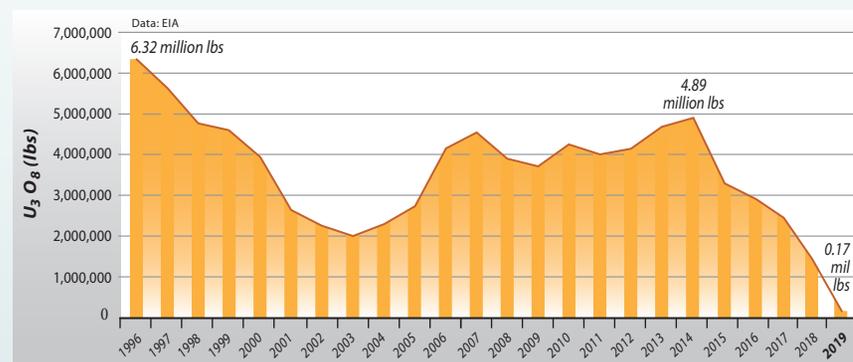


Figure 18. Annual production of uranium concentrate in U. S., 1996–2019.

uranium-rich area, located in southwestern Colorado. The DOE LM properties reportedly contain an estimated 13.5 million pounds of uranium resources and, as of July 2020, the 29 tracts were leased (DOE, 2020c). Additional information associated with uranium is discussed in the Other Exploration and Development Activities section of this report.

NON-FUEL MINERAL RESOURCES

Non-fuel mineral resources include metals, industrial minerals, and construction materials (e.g., cement, lime, sand, and gravel). The total U.S. 2019 non-fuel mineral production value was \$86.3 billion, a ~5% increase from last year's revised total of \$82.2 billion (USGS, 2020a). Colorado ranked 17th in U.S. non-fuel mineral production value and produced an estimated \$1.79 billion, or ~2.07% of the estimated total U.S. production value (USGS, 2020a). **Figure 19** shows the estimated non-fuel mineral production value in Colorado over time.

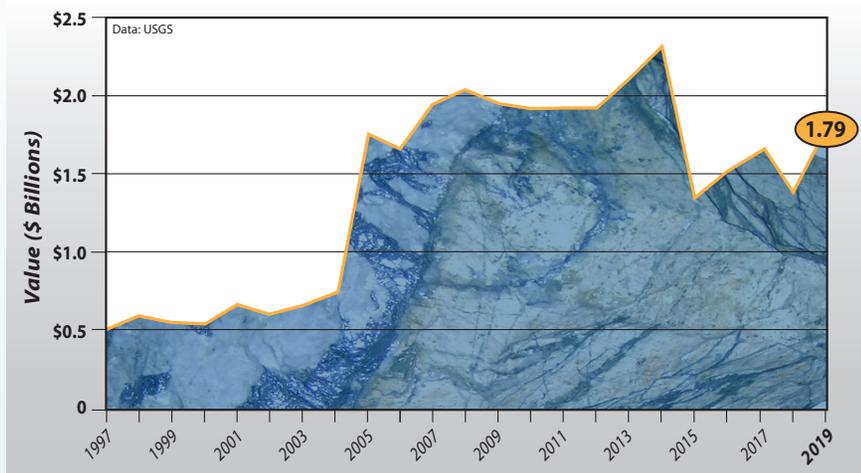


Figure 19. Total non-fuel mineral production value in Colorado, 1997–2019.

Metal Mining

Metals mined in Colorado include gold and molybdenum. The CGS estimates that the 2019 production value of gold and molybdenum in Colorado is ~\$781 million. This is ~10.8% lower than the value of these two commodities in 2018 of ~\$875.5 million mainly due to lower molybdenum production. Silver production in Colorado is a by-product of gold mining. Silver production values for Colorado were unavailable.

Molybdenum

In 2019, molybdenum was primarily used in metallurgical applications including the production of engineering steels (e.g., superalloys, nickel alloys, and tool steels), stainless steel, molybdenum metal and other alloys. The U.S. is the third largest producer of molybdenum in the world and produced an estimated 97

million pounds in 2019, valued at an estimated \$1.14 billion, based on average prices reported by the USGS (USGS, 2020a). This is ~6.2% higher than the 2018 estimated production of 91.3 million pounds. China is the top producer (~287 million pounds in 2019) and Chile is the second largest producer (estimated 119 million pounds in 2019) (USGS, 2020a).

Colorado's annual production and the average annual price per pound for molybdenum trioxide (MoO_3) are shown in **Figure 20**. Estimated average prices decreased from \$11.93 in 2018 to \$11.37 per pound in 2019 (Freeport, 2020b). However, these prices are still higher than the lower prices observed between 2015 and 2017 (~\$6.66 and \$8.21 per pound, respectively). A majority of the 2019 primary molybdenum production in the U.S. was from two Colorado mines that produced ~29 million pounds combined (Freeport, 2020b). In the U.S., Colorado ranked second in molybdenum production following molybdenum recovered as a by-product of copper mining at several Arizona mines (**Figure 21**).

In Colorado, molybdenum is mined at the Climax and Henderson mines by Freeport-McMoRan Inc. (Freeport). As reported by Freeport, the Climax Mine is located northeast of Leadville, at Fremont Pass. It includes a 25,000 metric ton per day mill with the ability to produce ~30 million pounds of molybdenum per year. The mine reopened in mid-2012 after being shut down for 17 years. Freeport reported that the Climax open pit mine produced 23 million pounds of molybdenum in 2015, 16 million pounds in 2016, 20 million pounds in 2017, 21 million pounds in 2018, and 17 million pounds in 2019. In 2019, Freeport also reported that the Climax Mine had 152 million metric tons of proven reserves at an average grade of 0.15% molybdenum and probable reserves of 8 million metric tons at an average grade of 0.09%.

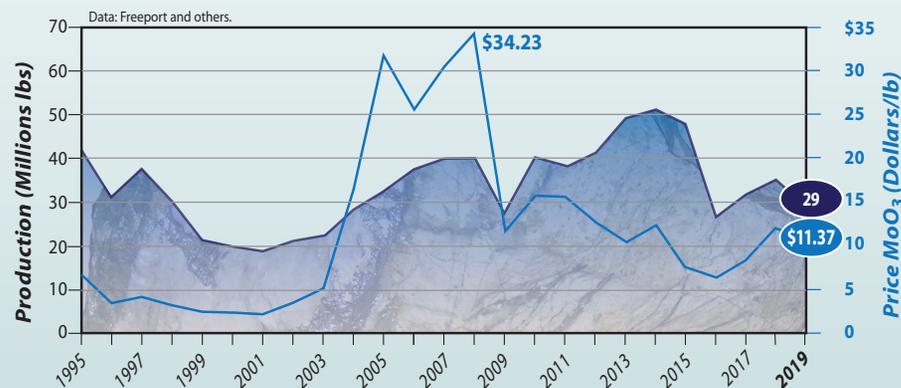


Figure 20. Molybdenum production in Colorado and average annual price 1995-2019.

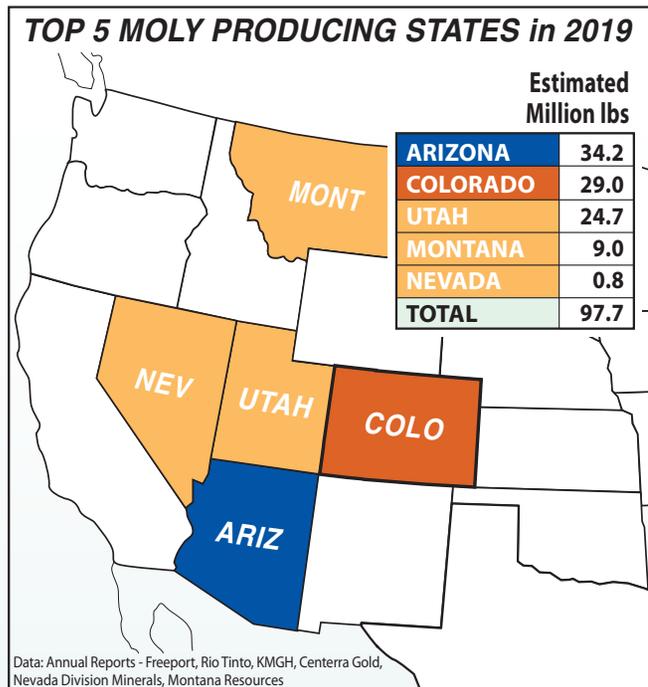


Figure 21. Top five molybdenum producing states, 2019.

The Henderson Mine, located near Empire in Clear Creek County, has been in operation since 1976. According to Freeport, this operation is a large block-cave underground mine connected to a 32,000 metric tons per day concentrator in adjoining Grand County by a 15-mile conveyor. Freeport reported that the Henderson Mine produced 25 million pounds of molybdenum in 2015, 10 million pounds in 2016, 12 million pounds in 2017, 14 million pounds in 2018, and 12 million pounds in 2019. In 2019, Freeport also reported that the Henderson Mine had 55 million metric tons of proven reserves at an average grade of 0.18% molybdenum and probable reserves of 12 million metric tons at an average grade of 0.13% (Freeport, 2020a).

Gold and Silver

U.S. gold production decreased from 226 tons (7.27 million troy ounces) in 2018 to an estimated 200 tons (6.43 million troy ounces) in 2019 with an estimated value of \$9.0 billion (USGS, 2020a). In 2019, the U.S. was the fourth largest producer of gold in the world following China (420 tons), Australia (330 tons), and Russia (310 tons) (USGS, 2020a). **Figure 22** shows the price of gold and Colorado gold production from 1990 to 2019. In 2019, Colorado was the third top producer of gold (322,000 ounces) in the U.S. (**Figure 23**) following Nevada

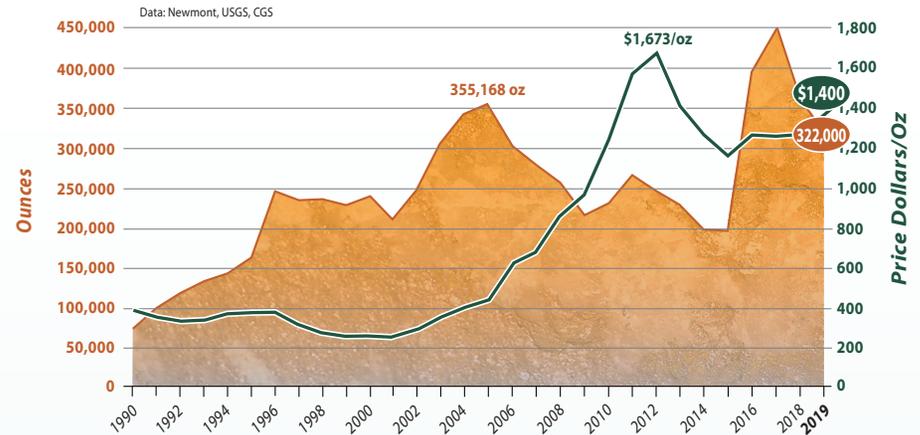


Figure 22. Colorado estimated gold production and average annual price per ounce, 1990–2019.

(~4,868,086 ounces) and Alaska (~629,047 ounces). The average gold price in 2019 was \$1,400 per ounce (USGS, 2020a).

Gold production at Newmont Corporation's (Newmont) Cripple Creek and Victor (CC&V) open pit mine located in Teller County decreased from 360,000 ounces in 2018 to 322,000 ounces in 2019 likely due to lower-grade ore milled at CC&V (Newmont, 2020b). Estimated average gold prices increased from \$1,272 per



Climax Mine in Summit County (photo by V. Matthews).

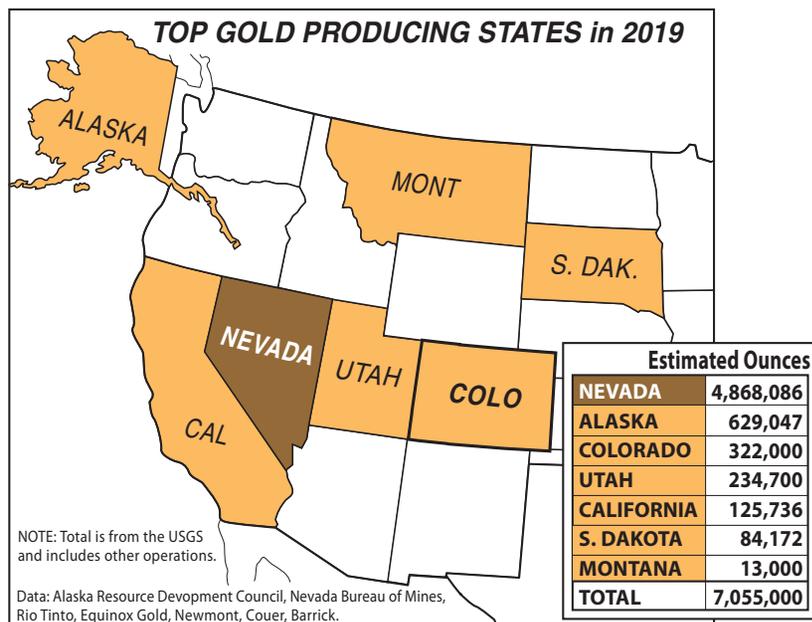


Figure 23. Major gold producing states in 2019.

ounce in 2019 to \$1,400 per ounce (USGS, 2020a). Silver is also produced from CC&V; however, silver production is not reported from this mine. In 2019, Newmont acquired Goldcorp Inc. and entered into a joint venture with Barrick Gold in Nevada making it the largest gold mining company in the world now known as Newmont Goldcorp. Their corporate headquarters remains in Greenwood Village, Colorado. Newmont operates mines all over the world. In 2019, it was the largest producer of gold in the world (NS Energy, 2020).

A smaller amount of placer gold is recovered from sand and gravel aggregate operations along some of Colorado's rivers and streams including the South Platte, Arkansas, and Colorado rivers, as well as Clear Creek. Additionally, a few small lode gold mines operated by private individuals or small groups likely produce, but do not report, small tonnages of high-grade gold and silver ore. Two of the larger gold placer mines in Colorado include the Alma Placer Mine and Hector Placer both located in Park County (DRMS, 2020b). There are currently 33 active mining permits with gold listed as the primary mined commodity in the Colorado Division of Reclamation, Mining and Safety (DRMS) database (DRMS, 2020a).

In 2018, Aurcana Silver Corporation (Aurcana) purchased Ouray Silver Mines Inc. (OSM) and continued to develop the Revenue-Virginus Mine for potential start-up operations. The mine will produce primarily silver, mostly associated

with quartz veins in volcanic rock, while recovering other metals such as gold, lead, and zinc as by-products. Located in Ouray County near the town of Ouray, the Revenue-Virginus was one of the largest and most historic mines in the county. The mine opened in 1876, with underground production beginning in 1880, and by 1921 had produced gold and silver ore worth more than \$28 million. A 2018 feasibility study for three vein systems at the mine reported proven and probable mineral reserves containing ~14.2 million ounces of silver with an average grade of 24.7 silver ounces per short ton. In 2019 and 2020, Aurcana focused on underground development and resource expansion plans in preparation for restarting mining operations. According to Aurcana, the mine is fully permitted for production (Aurcana, 2020).

Other Exploration Activities and Mining Information

In 2019, worldwide exploration budget estimates for nonferrous metals declined ~3% from 2018 but were above 2015 to 2017 levels. This includes planned spending for gold, silver, base metals, platinum group metals, diamonds, uranium, rare earth elements, and potash (S&P, 2020). The 2019 estimated global exploration budget for nonferrous metals was \$9.8 billion. Most of this estimated total budget is for exploration targeting gold (46%), copper (25%), and lead/zinc (6%). As it did in 2017, worldwide estimated exploration budgets for lithium increased in 2019 while cobalt exploration budgets reportedly decreased by 10% in 2019 (S&P, 2020).

Exploration and development projects that have undergone at least some recent activity are discussed below. Most of this information is compiled from company websites and available reports. Past CGS MEIA reports have additional information about these projects and updates associated with other properties including the Bates Hunter Mine, Gold Links Mine, Golden Wonder Mine, San Juan Silver Project, Silver Cliff Property, Tomichi Copper-Molybdenum Project, and Klondike Mine.

Zephyr Gold USA Ltd. (Zephyr), a wholly owned subsidiary of Zephyr Minerals Ltd., holds mineral claims at their **Dawson – Green Mountain Property** located southwest of Cañon City in Fremont County. The Dawson Project, located on the eastern end of the property, includes gold mineralized areas within a Precambrian-age granite and associated rocks. In 2018, Zephyr completed additional geological mapping, drilling, sampling, and a geophysical survey at the Dawson Property and also expanded its holdings to include a copper-gold prospect to the west named the Green Mountain Property. In 2019, they also leased a property in the center and adjacent to the Dawson-Green Mountain sections of the property called El Plomo. This area is reportedly a silver-lead-zinc prospect. Zephyr recently completed an airborne magnetic and electromagnetic survey at this property (O’Keeffe and Berry, 2020). In 2020, Zephyr completed

a drilling program and will focus on more exploration and development at their Dawson and Green Mountain properties (Zephyr, 2020a). They also plan on pursuing a mine permit for the Dawson gold deposit (Zephyr, 2020b). At El Plomo, Zephyr plans on mapping the geology in 2021 with a focus on structure, to determine potential zone of structural folding that may host mineralization, and, if warranted, a ground geophysical survey which may assist with future drilling activities (Zephyr, 2020c).

Late in 2019, Metallic Minerals Corp. (Metallic Minerals) announced that it entered into an agreement to perform exploration activities on their ***La Plata Property*** located in the La Plata mining district northwest of Durango. Reportedly, the property covers over 12 square miles and includes the Allard and Copper Hill areas. According to Metallic Minerals, previous exploration on the property confirmed the presence of an alkali copper porphyry system with associated epithermal silver and gold deposits. The igneous rocks in this area were intruded during the Late Cretaceous-early Tertiary into older sedimentary rocks. Spanish explorers reportedly observed operating mines in the La Plata Mountains in the 18th century. More recent historic mining in the area started around 1873 but most of the production appears to be from the early 1900s to at least the late-1930s and included gold, silver, copper, and lead (Eckel, 1949; Metallic Minerals, 2020a). In 2019, field work focused on mapping, prospecting, and soil sampling to assess the different styles of mineralization. Metallic Minerals is refining the three-dimensional geologic model from historic drilling and trenching to guide exploration (Metallic Minerals, 2020b). In 2020, they anticipated more exploration with underground sampling and drilling late in 2020 (Metallic Minerals, 2020c).

Uranium and Vanadium

There were recent several activities associated with uranium and vanadium properties in Colorado mainly within the Uravan mineral belt which generally extends from western Montrose and San Miguel counties through southwestern Mesa County (Nelson-Moore and others, 1978). The Uravan mineral belt contains uranium and vanadium deposits predominantly in the Salt Wash Member of the Jurassic Morrison Formation that have relatively closer spacing, larger size, and are higher grade than adjacent deposits (Nelson-Moore and others, 1978; Chenoweth, 1980). As reported by Chenoweth (1980), “the belt includes the Gateway, Uravan, Paradox, Bull Canyon, Gypsum Valley, and Slick Rock mining areas. Given recent exploration, it appears that the belt concept, developed over 25 years ago, is over-simplified and that large ore bodies in the Salt Wash are not restricted to the belt.” A few of the recent activities associated with the Uravan mineral belt are summarized below.

Thor Mining PLC (Thor) completed their acquisition of American Vanadium Pty Ltd in 2020 and now holds 199 adjacent claims that include the Radium

Mountain and Wedding Bell/Groudhog group claims in the Uravan mineral belt in western Colorado (Thor, 2020a). Thor completed a sampling program during their due diligence and reported that 13 assay results of higher radioactive samples averaged 0.706% U_3O_8 and 1.36% V_2O_5 (Thor, 2020b). In June 2020, Delecta Ltd. (Delecta) announced an investment in Sunrise Minerals Inc. (Sunrise) that holds the REX uranium-vanadium project that includes 256 contiguous claims in the Uravan mineral belt associated with historic uranium and vanadium production (Delecta, 2020). In 2019, Western Uranium and Vanadium Corporation (Western) conducted a mine re-opening project at their Sunday Mine Complex located in the Uravan Mineral Belt to identify high-grade vanadium ore and conduct development drilling (Western, 2020). According to Western, their mines are permitted with DRMS and are in temporary cessation status (Western, 2020).

Critical Minerals

The 2017 Presidential Executive Order (E.O.) No. 13817 entitled “*A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*,” ordered the creation of a critical minerals list. A critical mineral, as identified by the Secretary of the Interior (S.I.) in coordination with other federal agencies, was defined as a non-fuel mineral or mineral material essential to the economic and national security of the U.S., the supply chain of which is vulnerable to disruption and, that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security. The USGS, in coordination with the BLM, provided the draft critical mineral list, as documented in Fortier and others (2018). The critical minerals listed include (in alphabetical order): aluminum (bauxite), antimony, arsenic, barite, beryllium, bismuth, cesium, chromium, cobalt, fluorspar, gallium, germanium, graphite (natural), hafnium, helium, indium, lithium, magnesium, manganese, niobium, platinum group metals, potash, the rare earth element (REE) group, rhenium, rubidium, scandium, strontium, tantalum, tellurium, tin, titanium, tungsten, uranium, vanadium, and zirconium. In September 2020, an executive order was signed declaring a national emergency to reduce U.S. dependency on foreign countries for critical minerals (U.S. White House, 2020). Reportedly, the order “*begins the process for the Department of the Interior to develop a program to use its authorities under the Defense Production Act (DPA) to fund mineral processing that protects our national security.*”

Minerals containing almost all the elements provided in the critical mineral list occur in Colorado. However, many of these may not occur in sufficient quantities to mine economically. Colorado is a known producer or past producer of many of the minerals/mineral materials provided in the critical minerals list especially (in no particular order) helium, tungsten, uranium, and vanadium. Also, Colorado contains deposits of titanium, niobium, REE, and potentially

lithium, as well as other critical minerals that may be economical to extract. The CGS is currently working with the USGS to determine areas that may contain potential resources of critical minerals in Colorado. For more on critical minerals in Colorado, see the CGS website: <https://coloradogeologicalsurvey.org/minerals/strategic-critical/>.

In 2019 and 2020, the USGS hosted critical mineral workshops that include mineral geologists from the USGS and from state geological surveys across the U.S. These workshops consist of regional teams that determine critical mineral focus areas, or areas where critical minerals are likely to be deposited, using a mineral system approach (Hofstra and Kreiner, 2020). During these workshops, priority areas are selected for future geological mapping and other geological investigations related to critical minerals. Geological mapping projects associated with these priority areas are funded through the USGS Earth Mapping Resources Initiative (EarthMRI) with matching funds from state surveys. The CGS is currently working on a geological map of an area containing critical mineral deposits near the Wet Mountains in Fremont and Custer counties. This project is funded through EarthMRI with matching funds provided by the CGS (USGS, 2020b).

SEC Property Disclosures

In 2018, the U.S. Securities and Exchange Commission (SEC) announced their decision to amend current property disclosure requirements under the Securities Act of 1933 and Securities Exchange Act of 1934 (SEC, 2018). These amendments will require businesses with mining operations to disclose information with regards to mineral resources and reserves. The SEC will also include other requirements to provide investors with more specific information with regards to a business's mining operations and prospects. The SEC has determined that future compliance with these new amendments and rules will be required during the SEC registrant's first fiscal year beginning on or after January 1, 2021. More information and a link to the final rules are located on the SEC website located here: <https://www.sec.gov/rules/final/2018/33-10570.pdf>.

Proposed Federal Mining Law Reform

As reported in the last MEIA report (O'Keeffe and Berry, 2019), two proposed mining bills were introduced to federal legislators in 2019 including the Hardrock Mining and Reclamation Act of 2019 (S. 1386) (Congress, 2019), originally introduced in 2015, and the Hardrock Leasing and Reclamation Act of 2019 (H.R. 2579) (CBO, 2020). The current Mining Law of 1872 governs the

acquisition of federal public lands for minerals by the “*location and maintenance*” of mining claims (BLM, 2020). Locatable minerals include metallic-bearing minerals as well as some non-metallic minerals. Both of these bills attempt to modify current requirements associated with locatable minerals on federal public lands. The proposed S. 1386 imposes a royalty on hardrock mining, establishes a Hardrock Minerals Reclamation Fund to assist with abandoned mine cleanup, requires federal exploration and mining operation permits for “*non-casual*” mining operations, and reportedly “*encourages local autonomy over mining and gives states, political subdivisions, and Indian tribes the authority to petition the Secretary of the Interior to withdraw certain lands from mining*” (Bennet, 2020). In May 2019, this bill was referred to the U.S. Committee on Energy and Natural Resources (Congress, 2019). H.R. 2579 would reportedly establish a royalty on hardrock mining, require “*meaningful tribal consultation*”, allow management through existing land-use planning, establish “*special lands*” that cannot be mined, create new reclamation and bonding rules, and create a fund to assist with abandoned mine cleanup (NRC, 2019a). In October 2019, the U.S. Natural Resources Committee (NRC) voted to advance H.R. 2579 as well as two bills to protect miner pensions and health benefits (NRC, 2019b). As summarized by the U.S. Congressional Budget Office (CBO) (CBO, 2020).

“H.R. 2579 would change the terms for hardrock mining on federal land, mostly in the Western United States. The bill would not allow new claims to be made under the current system; instead, it would establish a leasing program. Production from existing hardrock mines would be subject to a royalty of 8 percent; royalties, rents, and fees also would be levied on new leases and production; and the budgetary classification of claim maintenance fees would be changed. In addition, 25 percent of all royalties, rents, and certain other fees collected would be paid to the state in which the minerals are produced. H.R. 2579 would establish the Hardrock Minerals Reclamation Fund and would require royalties, rents, and fees remaining after payments to the states be deposited into that fund. The bill would authorize appropriations from the fund to be used for mining reclamation. The Department of the Interior (DOI) and the Forest Service would be responsible for related administration, inspections, and consultation with tribes. Finally, the bill would require hardrock mining operators to pay royalties, rents, and other fees on their activities on federal land and would terminate current mining-related cooperative agreements between federal agencies and the states and require new agreements consistent with the bill.”

AGGREGATE – SAND, GRAVEL, AND CRUSHED STONE

In 2019, the primary uses of construction sand and gravel are for concrete aggregates, road base and coverings, road stabilization, construction fill, asphaltic concrete and other bituminous mixtures, and other concrete products (USGS, 2020a). Other uses include plaster and gunite sands, snow and ice control, filtration, railroad ballast, and roofing granules (USGS, 2020a). In 2019, crushed stone was primarily used for construction aggregate especially for road construction and maintenance, cement manufacturing, lime manufacturing, and for other uses (USGS, 2020a). DRMS currently lists over 800 active permits for sand, gravel, aggregate, and aggregate-related quarries in Colorado (DRMS, 2020a).

Colorado quarry operators produced 50.93 million tons of aggregate (sand, gravel, and crushed stone) in 2019 (USGS, 2020a) (**Figure 24**). Colorado was the tenth leading producer of construction sand and gravel in the U.S. and the estimated 2019 production value was \$266 million for sand and gravel and \$167 million for crushed stone (USGS, 2020a). Average prices and production for sand and gravel and crushed stone are shown in **Figure 25** and **Figure 26**, respectively.

Colorado uses a large amount of aggregate to build and maintain infrastructure. The cost of aggregate to the user is highly dependent on aggregate transportation costs. Locating quarries close to population centers helps lower overall costs. However, residential and commercial development near an aggregate source can make permitting a new or expanding quarry a challenge. To help local governments identify potential sources of sand, gravel and quarry aggregates, the CGS published maps of sand, gravel, and quarry aggregate resources for

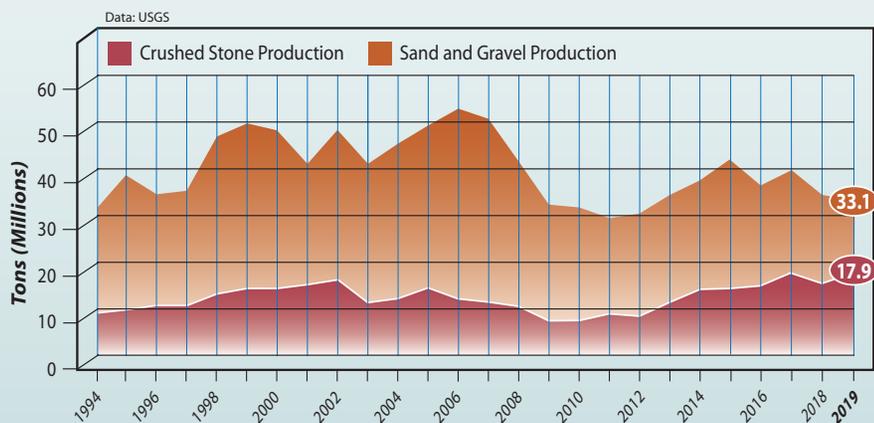


Figure 24. Aggregate production in Colorado, 1994–2019.

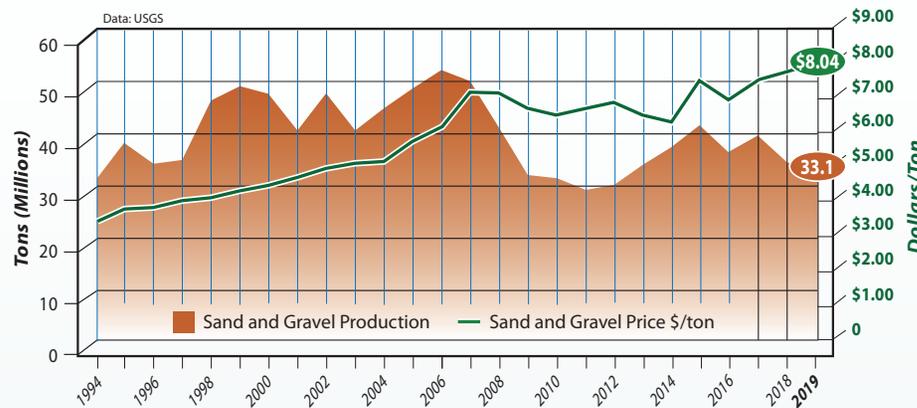


Figure 25. Price and production of sand and gravel aggregate in Colorado, 1994–2019.

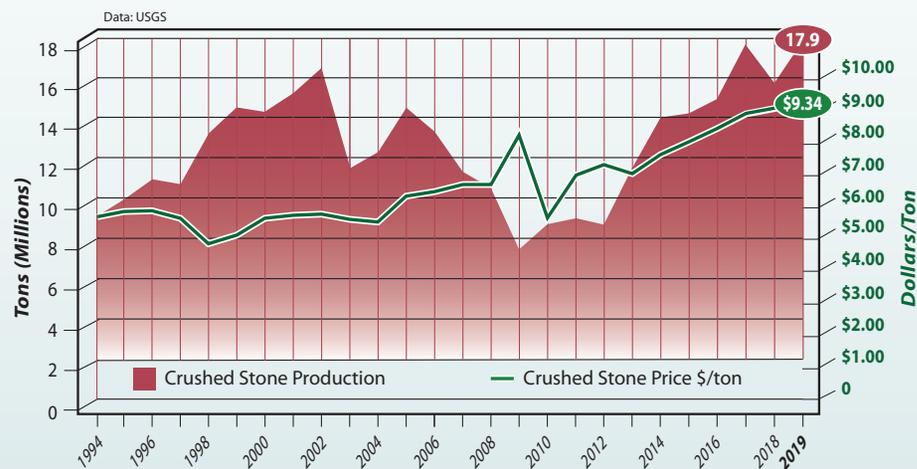


Figure 26. Price and production of crushed stone aggregate in Colorado, 1994–2019.

Colorado Front Range counties which are available for download on our website (Schwochow and others, 1974). Digital versions of these aggregate resource maps can be found in another CGS publication (OF-00-09 Atlas of Sand, Gravel, & Quarry Aggregate Resources, Colorado Front Range) that is available for download on our website (Cappa and others, 2000). These maps are also available in a CGS online interactive map viewer available at the following location (copy/paste links to browser):

<https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=003cf86ff0e6440989b1496e368c115e>

For additional information, please see the following website:

<https://cologeosurvey.maps.arcgis.com/apps/MapSeries/index.html?apid=e2f8ad18c3384707a65cc4b03f15280c>

In November 2019, [Rep. Stanton, Greg \[D-AZ-9\]](#) introduced the Rebuilding Our Communities (ROCKS) Act (H.R. 5117 of the 116th Congress) was introduced to the U.S. Congress. This bill would “*establish a working group of federal, state, tribal, and local stakeholders to conduct a study on the regulatory and legislative improvements necessary to preserve access to covered resources and reduce the costs and environmental impacts of infrastructure projects*” (U.S. Congress, 2019). Covered resources include stone, sand, and gravel for the construction and maintenance of roads and structures. Congress later incorporated into the Investing in a New Vision for the Environment and Surface Transportation in America (INVEST in America) Act (H.R. 7095 of the 116th Congress) introduced in June 2020 (U.S. Congress, 2020a). The INVEST in America Act includes the establishment of a working group on construction resources to conduct a study on access to covered resources for infrastructure projects. The working group would include representatives from state departments of transportation, state agencies associated with covered resources protection, state planning and geologic survey and mapping agencies, commercial motor vehicle operators, covered resources producers, construction contractors, metropolitan/regional planning organizations, Indian Tribes, and potentially other stakeholders. The study would include analyses of the use of covered resources in Federally funded transportation projects and how the proximity of covered resources to these projects affects costs and the environment impact (U.S. Congress, 2020a). In July 2020, the U.S. House of Representatives passed the Moving Forward Act (H.R. 2) which includes, and reportedly adds additional details to, the INVEST in America Act (U.S. Congress 2020b).

Cement

Portland cement in Colorado is used primarily in the production of concrete. Concrete consists of a mixture of aggregates (e.g., sand, gravel, or crushed stone) mixed with water and cement. According to the Portland Cement Association (PCA, 2020), cement is created by heating lime, silica, alumina, iron, and other materials at high temperatures which creates small round pellets called clinkers that are ground, mixed with limestone and gypsum, and used to make concrete. Three Portland cement plants operated in Colorado during 2019: LafargeHolcim (US), Inc. (LafargeHolcim) in Florence, the GCC of America plant in Pueblo, and CEMEX plant near Lyons. All three mining companies are currently mining the Niobrara Formation as feed stock for their cement products. Like the aggregate business, the production of cement is largely tied to the construction industry. Estimated Portland cement production (e.g., shipments from Colorado) in 2019 was 2.6 million tons (USGS, 2020c). Production and average cement prices are shown on **Figure 27**. In 2017, CR Minerals based in New Mexico opened up a

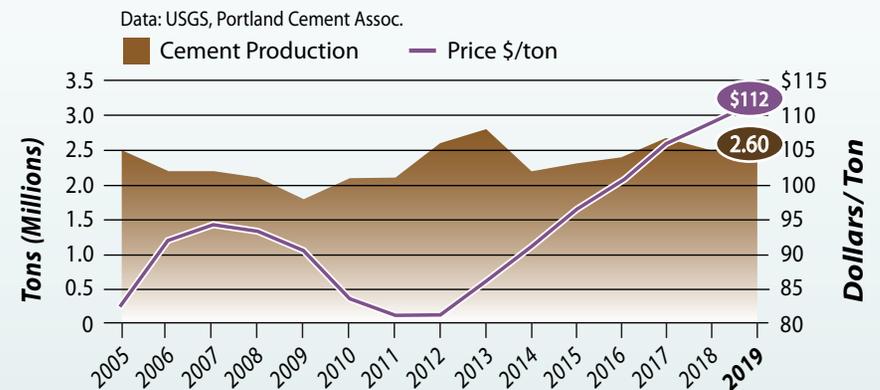


Figure 27. Price and production of cement in Colorado, 2005–2019.

Sand and gravel operation in Morgan County (photo by Matt Morgan).



manufacturing facility in Pueblo, Pueblo County, to produce high-quality pumice products (CR Minerals, 2020). The applications include additives in cement for stone veneer, concrete block, landscape rock as well as a new product that mixes pumice with fly ash (from the Comanche Power plant) which increases the life of cement in the ready mix process (PEDCO, 2020; CR Minerals, 2020). Fly ash is a fine-grained powder residue from burning coal. In 2020, CR Minerals announced an expansion of the facility.

According to the International Energy Agency (IEA), the cement sector is reportedly the second largest industrial source of carbon dioxide in the world and production is estimated to rise by 12 to 23% globally by 2050 due to increases in population and infrastructure construction (IEA, 2018). In 2020, the DOE's National Energy Technology Laboratory (NETL) awarded a \$1.5 million grant to support an engineering analysis and advancement of a commercial-scale carbon-capture project in Colorado (LaFargeHolcim, 2020). An initial scoping study was completed in June 2020 and the NETL funding will support a feasibility study to be completed by a partnership of several companies including LaFargeHolcim. The study will review the carbon-capture facility design to capture up to 2 million metric tons of carbon dioxide from the LaFargeHolcim cement plant in Florence, Fremont County. The goal is to be the first to use the technology (provided by team member Svante, Inc.) at a commercial scale (LarfargeHolcim, 2020; Daily Record, 2020). Reportedly, the goal is to have the system operational in 2024 (Daily Record, 2020).

Clay and Shale

Clay is mined primarily in eastern Colorado along the Front Range and is used mostly to make brick and tile. Clay has been mined from the Laramie Formation, Dawson Arkose, and Denver Formation as well as the Dakota Group. DRMS records indicate that there are 43 active permits for clay in Colorado (DRMS, 2020a). Two brick companies currently operate in the Denver area: the old Robinson Brick Co., owned by General Shale/Wienerberger, and Summit Brick Co. The Summit Brick Co. also operates a brick making plant in Pueblo (Summit Brick Company, 2020). The Acme Brick Co. brick plant in Castle Rock, Douglas County, shut down in 2018. Preliminary common clay and shale production was estimated at 251,000 tons in 2015 and 222,000 tons in 2016 (USGS, 2016b). The estimated average price of common clay was ~\$17.00 per ton in 2019 (USGS, 2020a). Published production estimates for clay and shale have been unavailable since 2016.

Gypsum

Gypsum mined in Colorado is used for the production of wallboard, as an ingredient in cement production, as a soil conditioner, and for other industrial uses such as glass making and smelting. In 2018, Colorado was one of the top

six states in the U.S. that accounted for 67% of the total gypsum mine output (USGS, 2019). There are currently 8 active mine permits associated with gypsum in Colorado (DRMS, 2020a). American Gypsum Co. operates a large quarry and fabrication plant for wallboard in Eagle County, near the town of Gypsum, and is the fifth largest producer of gypsum wallboard in North America (American Gypsum, 2020). In 2020, the BLM approved a 100-acre expansion of American Gypsum's mine in Eagle County following a public comment period. The current mine has been operating since 1984 and the expansion adds ~40 years to the mine reserves (Vail Daily, 2020). Currently, the mine and gypsum plant produces ~600 million square feet annually (Vail Daily, 2020).

Pete Lien & Sons mines gypsum for the cement industry and soil amendment from the Munroe Quarry north of Fort Collins in Larimer County (Lien, 2020). Gypsum is also mined in Fremont county. Crude gypsum 2019 production in the U.S. is 20 million tons (USGS, 2020a). Information on gypsum produced in Colorado is unavailable for proprietary reasons.

Sodium Bicarbonate (Nahcolite)

Sodium bicarbonate (more commonly known as baking soda) is primarily used in food preparation and baking, personal care products, pharmaceuticals, animal feed products, pool and water treatment, and other applications. Natural Soda, Inc. (Natural Soda), owned by Rincon Ltd., operates a nahcolite solution mine in Rio Blanco County. Nahcolite is the naturally occurring mineral of sodium bicarbonate (NaHCO_3). High grade nahcolite (greater than 80%) is recovered from the Parachute Creek Member of the Eocene Green River Formation in the Piceance Basin. Mine operators pump hot water down a well ~1,900 feet deep to dissolve the nahcolite. Other wells recover the sodium bicarbonate-enriched solution and pump it to the surface where the solution is allowed to cool and precipitate sodium bicarbonate which is further dried and prepared to produce commercial grade product (Hardy and others, 2003; Brownfield and others, 2010). The USGS estimated that the Parachute Creek Member of the Eocene Green River Formation in the Piceance Basin, Rio Blanco County, contains an estimated in-place resource of over 43 billion short tons of nahcolite over a ~170,000 acre area (USGS, 2009). Natural Soda completed an expansion project in 2013 to double the mine's production capacity to 250,000 tons per year. Production in 2018 and 2019 was 188,000 and 231,562 tons, respectively (**Figure 28**) (DRMS, 2020a).

Silica

Sand is mined in Colorado for use as a silica additive in cement manufacturing. Well-rounded quartz sand from eolian deposits has been mined for filtration and water well packing purposes. Depending on the application and other factors, silica prices are highly variable. In 2017, the average national price for

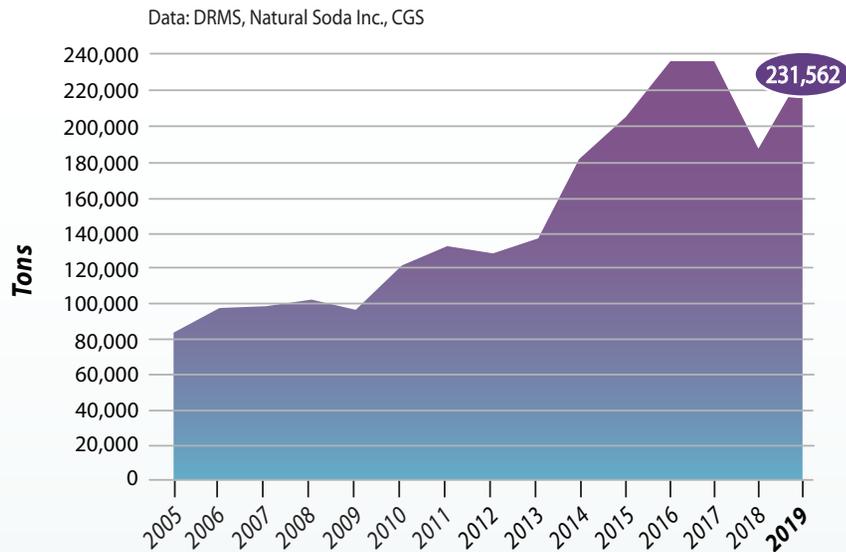


Figure 28. Estimated production of nahcolite in Colorado, 2005–2019.

industrial silica sand and gravel reported by the USGS was \$53.10 per metric ton. As reported by the USGS, the production value of industrial sand and gravel in 2018 increased by 22% over the last year and by 130% when compared to 2016 production values. This increase has been mainly due to an increase in demand for hydraulic fracturing sand (also called “frac” or “proppant” sand). These sands are used in the hydraulic fracturing process to prop open rock fractures and facilitate the flow of oil and gas to wells. In 2017, about 73% of industrial sand and gravel sold or used by U.S producers was used for hydraulic fracturing and well packing and cementing. Production information of industrial sand in Colorado was not available. The CGS published a 2018 reconnaissance study of potential sources of sand for hydraulic fracturing available in Colorado:

<https://store.coloradogeologicalsurvey.org/product/potential-sand-sources-hydraulic-fracturing/>.

Dimension and Decorative Stone

Dimension stone is any visually appealing rock that is quarried, cut, or shaped into useful forms. Colorado has many dimension stone and decorative stone producers who quarry sandstone, granite, marble, rhyolite, and alabaster (a form of gypsum) for use as dimension stone. Dimension stone is used to construct buildings, wall cladding or veneer, monuments, floor tiles, walk ways (flagstone), landscaping features, and sculptures. Decorative stone is any type of rock that is used in its natural form for aesthetic purposes. In Colorado, various types of rock are mined locally for decorative use. **Figure 29** shows Colorado dimension stone production for the period from 2005 to 2017 (USGS, 2018). Colorado produced ~32,850 tons of dimension stone in 2017 with an estimated production value of \$11.9 million (USGS, 2018). Data for Colorado dimension stone production have been unavailable since 2017. In 2019, Colorado was a minor producer while Texas, Wisconsin, Indiana, Georgia and Vermont accounted for ~68% of U.S. production (USGS, 2020a). The majority of rock types sold in the U.S. in 2019 by descending value included limestone, sandstone, granite, miscellaneous stone, marble, and slate (USGS, 2020a).

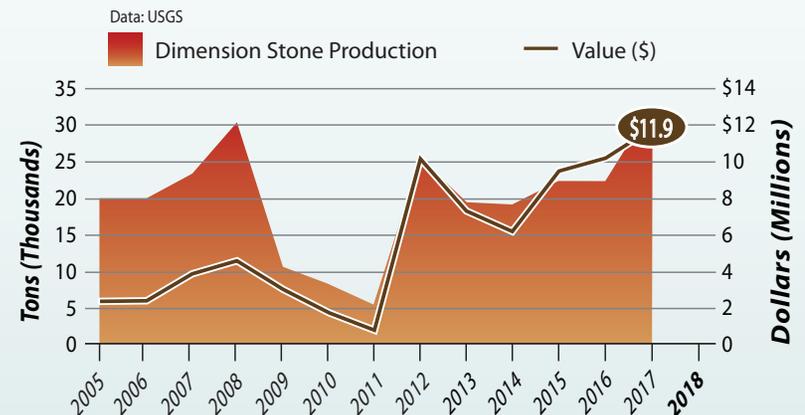


Figure 29. Production and product value of dimension stone in Colorado, 2005–2017.

INDUSTRIAL GASES (NON ENERGY)

Carbon Dioxide

Naturally occurring carbon dioxide gas (CO₂) was produced in 2018 primarily from three areas in Colorado: McElmo Dome in Montezuma County, Doe Canyon Deep in Dolores County, and the Sheep Mountain Field in Huerfano County. McCallum Field in Jackson County and the Rangely Field in Rio Blanco County have also produced CO₂ in the past. Kinder Morgan's McElmo Dome and the Doe Canyon Deep units are the largest producers in Colorado. CO₂ is produced from wells in a similar way to natural gas production. Oil producers mainly use CO₂ in enhanced oil recovery (EOR) in Texas and New Mexico. EOR is implementing various techniques for increasing the extraction of crude oil from an oil field. EOR is also called improved oil recovery or tertiary recovery (as opposed to primary and secondary recovery). CO₂ is used to extend the life of a well after the initial pressure in the well decreases. Other uses for CO₂ include welding gases, manufacture of dry ice, and in the food and beverage industry. In 2018, Colorado produced an estimated 419 billion cubic feet (Bcf) at an estimated average price of \$1.02 per thousand cubic feet (Mcf) for an estimated value of \$428 million. **Figure 30** shows Colorado's estimated CO₂ production for the period 1994-2019. CO₂ production from Montezuma County, McElmo Dome, accounted for ~93% of the total Colorado production (COGCC, 2020a).

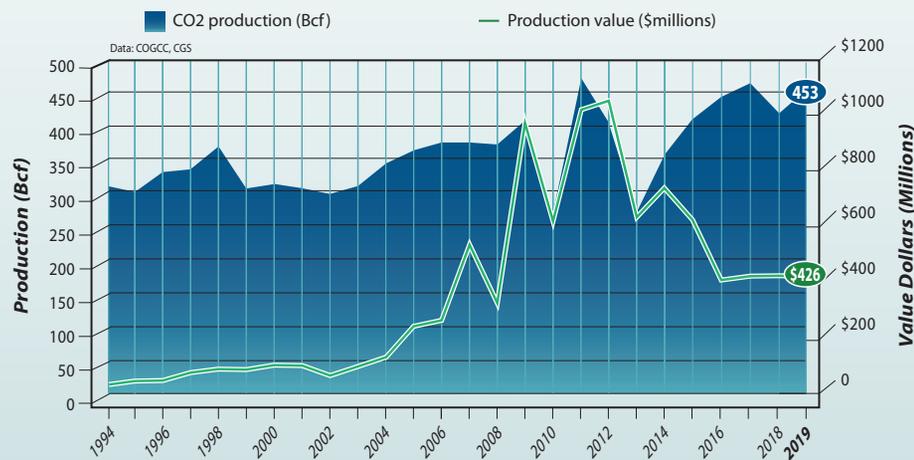


Figure 30. CO₂ production and estimated production value in Colorado, 1994–2019.

Helium

In 2019, helium was primarily used for magnetic resonance imaging, lifting gas (e.g., for lifting high-altitude equipment), analytical and laboratory applications, welding, and other applications including engineering/scientific applications, leak detection, and semiconductor manufacturing (USGS, 2020a). The price for private industry grade-A helium in 2019 was ~\$210 per Mcf (USGS, 2020a). Currently, the BLM manages the Federal Helium System under the Helium Stewardship Act of 2013. The BLM will terminate its management of the federal helium system and reserve at the end of September 2021 when remaining helium will be transferred to the U.S. General Services Administration which will start their statutory disposal process (BLM, 2020b). As indicated by a BLM representative, “Now it is time for the U.S. government to remove itself from the helium business and allow the private sector to further develop this industry to meet the supply needs of the United States, creating a sustainable economic model and jobs for Americans” (BLM, 2020b).

The southeastern Colorado Ladder Creek gas plant facility, located in Cheyenne Wells, Cheyenne County, produces Grade-A helium. In late 2019, Tumbleweed Midstream LLC (Tumbleweed) purchased the facility from DCP Midstream LLC (Tumbleweed, 2020). In mid-2020, Tumbleweed indicated they would quadruple helium production at Ladder Creek. They noted that they would double the inlet volume, which is now at 12 million cubic feet (MMcf) per day and reportedly increase production by an additional 3 to 5 MMcf per day at some point (Tumbleweed, 2020). Tumbleweed expects the facilities helium production will increase to more than 65 MMcf per year, with daily helium production at 200 Mcf per day (Tumbleweed, 2020). In 2015, Air Products and Chemicals, Inc. (Air Products) built a helium production facility in Doe Canyon. They extract most of the helium from a gas stream composed primarily of carbon dioxide. The plant has a capacity of ~230 MMcf per year and 2019 production is reportedly ~140 MMcf per year (Edison, 2019). IACX Energy (IACX), a midstream company, reportedly has an agreement with a producer to install nitrogen rejection units (NRUs) and a helium recovery unit in the Badger Wash area in Mesa County (IACX, 2020).

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