

# COBALT

(Data in metric tons of contained cobalt unless otherwise noted)

**Domestic Production and Use:** In 2022, the nickel-copper Eagle Mine in Michigan produced cobalt-bearing nickel concentrate. In Missouri, a company produced nickel-copper-cobalt concentrate from historic mine tailings and was building a hydrometallurgical processing plant near the mine site. In October, commissioning began at a cobalt-copper-gold mine and mill in Idaho, where cobalt concentrate will be produced. This mine and one in Morocco are the only mines in the world where cobalt is the principal product. Most U.S. cobalt supply consisted of imports and secondary (scrap) materials. About six companies in the United States produced cobalt chemicals. An estimated 40% of the cobalt consumed in the United States was used in superalloys, mainly in aircraft gas turbine engines; 35% in a variety of chemical applications; 15% in various other metallic applications; and 10% in cemented carbides for cutting and wear-resistant applications. The total estimated value of cobalt consumed in 2022 was \$530 million.

<b>Salient Statistics—United States:</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022<sup>e</sup></b>
Production: <sup>e</sup>					
Mine	480	500	600	650	800
Secondary <sup>1</sup>	2,750	2,750	2,010	1,800	1,900
Imports for consumption	11,900	13,900	9,740	9,800	11,000
Exports	6,980	4,080	3,430	4,930	5,100
Consumption (includes secondary):					
Estimated <sup>2</sup>	9,290	9,050	7,260	7,200	7,800
Apparent <sup>e, 3</sup>	7,680	12,500	8,470	6,600	7,800
Price, average, dollars per pound:					
U.S. spot, cathode <sup>4</sup>	37.43	16.95	15.70	24.21	31
London Metal Exchange (LME), cash	32.94	14.88	14.21	23.17	29
Stocks, yearend:					
Industry <sup>e, 2, 5</sup>	1,060	1,090	952	1,010	1,000
LME, U.S. warehouse	130	102	82	50	30
Net import reliance <sup>6</sup> as a percentage of apparent consumption	64	78	76	73	76

**Recycling:** In 2022, cobalt contained in purchased scrap represented an estimated 24% of estimated cobalt consumption.

**Import Sources (2018–21):** Cobalt contained in metal, oxide, and salts: Norway, 22%; Canada, 16%; Finland, 12%; Japan, 12%; and other, 38%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–22</b>
	Cobalt ores and concentrates	2605.00.0000	Free.
	Chemical compounds:		
	Cobalt oxides and hydroxides	2822.00.0000	0.1% ad valorem.
	Cobalt chlorides	2827.39.6000	4.2% ad valorem.
	Cobalt sulfates	2833.29.1000	1.4% ad valorem.
	Cobalt carbonates	2836.99.1000	4.2% ad valorem.
	Cobalt acetates	2915.29.3000	4.2% ad valorem.
	Unwrought cobalt, alloys	8105.20.3000	4.4% ad valorem.
	Unwrought cobalt, other	8105.20.6000	Free.
	Cobalt mattes and other intermediate products;		
	cobalt powders	8105.20.9000	Free.
	Cobalt waste and scrap	8105.30.0000	Free.
	Wrought cobalt and cobalt articles	8105.90.0000	3.7% ad valorem.

**Depletion Allowance:** 22% (domestic), 14% (foreign).

**Government Stockpile:**<sup>7</sup> See the Lithium chapter for statistics on lithium-cobalt oxide and lithium-nickel-cobalt-aluminum oxide.

<b>Material</b>	<b>FY 2022</b>		<b>FY 2023</b>		
	<b>Inventory as of 9–30–22</b>	<b>Potential acquisitions</b>	<b>Potential disposals</b>	<b>Potential acquisitions</b>	<b>Potential disposals</b>
Cobalt	302	—	—	—	—
Cobalt alloys, gross weight <sup>8</sup>	14	50	—	—	—

Prepared by **Kim B. Shedd [(703) 648–4974, kshed@usgs.gov]**

## COBALT

**Events, Trends, and Issues:** Global cobalt mine and refinery production were forecast to increase to record-high levels in 2022. The increase in mine production was mainly in Congo (Kinshasa) and in Indonesia, where new mining and processing projects were starting production. Congo (Kinshasa) continued to be the world's leading source of mined cobalt, accounting for about 70% of world cobalt mine production. With the exception of some production in the United States, production in Morocco, and artisanally mined cobalt in Congo (Kinshasa), most cobalt is mined as a byproduct of copper or nickel. China was the world's leading producer of refined cobalt, most of which was produced from partially refined cobalt imported from Congo (Kinshasa). China was the world's leading consumer of cobalt, with about 80% of its consumption used by the rechargeable battery industry.

**World Mine Production and Reserves:** Reserves for Australia, China, and Congo (Kinshasa) were revised based on company and Government reports.

	Mine production		Reserves <sup>9</sup>
	2021	2022 <sup>e</sup>	
United States	<sup>e</sup> 650	800	69,000
Australia	5,295	5,900	<sup>10</sup> 1,500,000
Canada	4,361	3,900	220,000
China	<sup>e</sup> 2,200	2,200	140,000
Congo (Kinshasa)	<sup>e</sup> 119,000	130,000	4,000,000
Cuba	<sup>e</sup> 4,000	3,800	500,000
Indonesia	<sup>e</sup> 2,700	10,000	600,000
Madagascar	<sup>e</sup> 2,800	3,000	100,000
Morocco	<sup>e</sup> 2,300	2,300	13,000
Papua New Guinea	2,953	3,000	47,000
Philippines	<sup>e</sup> 3,600	3,800	260,000
Russia	<sup>e</sup> 8,000	8,900	250,000
Turkey	<sup>e</sup> 2,400	2,700	36,000
Other countries	<u>4,567</u>	<u>5,200</u>	<u>610,000</u>
World total (rounded)	165,000	190,000	8,300,000

**World Resources:**<sup>9</sup> Identified cobalt resources of the United States are estimated to be about 1 million tons. Most of these resources are in Minnesota, but other important occurrences are in Alaska, California, Idaho, Michigan, Missouri, Montana, Oregon, and Pennsylvania. With the exception of resources in Idaho and Missouri, any future cobalt production from these deposits would be as a byproduct of another metal. Identified world terrestrial cobalt resources are about 25 million tons. The vast majority of these resources are in sediment-hosted stratiform copper deposits in Congo (Kinshasa) and Zambia; nickel-bearing laterite deposits in Australia and nearby island countries and Cuba; and magmatic nickel-copper sulfide deposits hosted in mafic and ultramafic rocks in Australia, Canada, Russia, and the United States. More than 120 million tons of cobalt resources have been identified in polymetallic nodules and crusts on the floor of the Atlantic, Indian, and Pacific Oceans.

**Substitutes:** Depending on the application, substitution for cobalt could result in a loss in product performance or an increase in cost. The cobalt contents of lithium-ion batteries, the leading global use for cobalt, are being reduced; potential commercially available cobalt-free substitutes use iron and phosphorus. Potential substitutes in other applications include barium or strontium ferrites, neodymium-iron-boron alloys, or nickel-iron alloys in magnets; cerium, iron, lead, manganese, or vanadium in paints; cobalt-iron-copper or iron-copper in diamond tools; copper-iron-manganese for curing unsaturated polyester resins; iron, iron-cobalt-nickel, nickel, ceramic-metallic composites (cermets), or ceramics in cutting and wear-resistant materials; nickel-base alloys or ceramics in jet engines; nickel in petroleum catalysts; rhodium in hydroformylation catalysts; and titanium-base alloys in prosthetics.

<sup>e</sup>Estimated. — Zero.

<sup>1</sup>Estimated from consumption of purchased scrap.

<sup>2</sup>Includes reported data and U.S. Geological Survey estimates.

<sup>3</sup>Defined as secondary production + imports – exports ± adjustments for Government and industry stock changes for refined cobalt.

<sup>4</sup>Source: Platts Metals Week. Cobalt cathode is refined cobalt metal produced by an electrolytic process.

<sup>5</sup>Stocks held by consumers and processors; excludes stocks held by trading companies and held for investment purposes.

<sup>6</sup>Defined as imports – exports ± adjustments for Government and industry stock changes for refined cobalt.

<sup>7</sup>See Appendix B for definitions.

<sup>8</sup>Inventory is cobalt alloys; potential acquisitions are samarium-cobalt alloy; excludes potential disposals of aerospace alloys.

<sup>9</sup>See Appendix C for resource and reserve definitions and information concerning data sources.

<sup>10</sup>For Australia, Joint Ore Reserves Committee-compliant or equivalent reserves were 670,000 tons.