

COBALT, ANTIMONY COMPOUNDS, AND WEAPONS-GRADE TUNGSTEN ALLOY

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Table S1.3 Global production of cobalt from mining, by country^a

Country ^b	Cobalt content (tonnes)					Rate of increase, 2015–2019
	2015	2016	2017	2018	2019	
Australia	5 721	5 140	5 034	4 878	5 742	0.4%
Botswana	316	248	–	–	–	NC
Brazil	2 771	852	185	–	30	–98.9%
Canada	4 339	4 216	3 704	3 279	3 336	–23.1%
China	2 600	2 300	2 500	2 000	2 500	–3.8%
Cuba	4 000	3 900	3 900	3 500	3 800	–5.0%
Democratic Republic of the Congo	72 000	68 000	80 000	104 000	100 000	38.9%
Finland	440	690	1 000	1 377	1 454	230.5%
Indonesia	1 300	1 200	1 200	1 200	1 100	–15.4%
Madagascar	4 000	3 800	3 600	3 300	3 400	–15.0%
Mexico	–	980	1 000	1 400	1 100	NC
Morocco	1 500	1 600	2 300	2 300	2 300	53.3%
France (New Caledonia)	3 640	3 390	2 780	2 100	1 700	–53.3%
Papua New Guinea	2 505	2 191	3 308	3 275	2 911	16.2%
Philippines	4 300	4 000	4 600	4 750	5 100	18.6%
Russian Federation	6 200	5 500	5 900	6 100	6 300	1.6%
South Africa	3 000	2 300	2 300	2 300	2 100	–30.0%
Türkiye	NA	100	220	259	120	NC
USA	760	690	640	480	500	–34.2%
Viet Nam	277	134	–	–	–	NC
Zambia	1 700	600	990	835	420	–75.3%
Zimbabwe	355	409	445	403	400	12.7%
Total	122 000	112 000	126 000	148 000	144 000	18.0%

–, zero; NC, not calculated.

^a Figures represent recoverable cobalt content from ores, concentrates, or intermediate products from cobalt, copper, nickel, platinum, or zinc operations.

^b In addition to the countries listed, Spain may have produced cobalt, but available information was inadequate to make reliable estimates of output. Other copper-, iron (pyrite)-, nickel-, platinum-, or zinc-producing nations may also produce ores containing cobalt as a by-product component, but recovery is small or nil.

Data from [USGS \(2021\)](#).

References

- ACGIH (2019). Cobalt and inorganic compounds. TLVs and BEIs based on the documentation of the threshold limit values for chemical substances and physical agents & biological exposure indices. Cincinnati (OH), USA: American Conference of Governmental Industrial Hygienists. Available from: <https://www.acgih.org>.
- Basketter DA, Angelini G, Ingber A, Kern PS, Menné T (2003). Nickel, chromium and cobalt in consumer products: revisiting safe levels in the new millennium. *Contact Dermatitis*. 49(1):1–7. doi:[10.1111/j.0105-1873.2003.00149.x](https://doi.org/10.1111/j.0105-1873.2003.00149.x) PMID:[14641113](https://pubmed.ncbi.nlm.nih.gov/14641113/)
- EFSA (2009) EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP); Scientific Opinion on the use of cobalt compounds as additives in animal nutrition. *EFSA Journal*. 7(12):1383. [45 pp.]. doi:[10.2903/j.efsa.2009.1383](https://doi.org/10.2903/j.efsa.2009.1383)
- Environment Agency (2022). Derivation and use of soil screening values for assessing ecological risks. Report – ShARE id26 (revised). Bristol, UK: Environment Agency. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047897/Soil_screening_values_for_assessing_ecological_risk_report.pdf, accessed 2 March 2022.
- European Commission (2009a). Annex 3 to the Commission Staff Working Document accompanying the Report from the Commission in accordance with Article 3.7 of the Groundwater Directive 2006/118/EC on the establishment of groundwater threshold values. Information on the groundwater threshold values of the Member States. Brussels, Belgium: European Commission. Available from: https://ec.europa.eu/environment/water/water-framework/groundwater/pdf/com_sw_d_annex_iii.pdf, accessed 1 February 2022.
- European Commission (2009b). Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys. Brussels, Belgium: European Commission. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02009L0048-20210521&from=EN>, accessed 14 March 2022.
- European Commission (2010). Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). Recast. Brussels, Belgium: European Commission. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02010L0075-20110106&from=DE>, accessed 15 March 2022.
- Fréry N, Saoudi A, Garnier R, Zeghnoun A, Falq G (2011). Exposition de la population française aux substances chimiques de l'environnement. Tome 1: Présentation générale de l'étude. Métaux et métalloïdes. Saint-Maurice, France: Institut de Veille Sanitaire. Available from: <https://www.santepubliquefrance.fr/determinants-de-sante/exposition-a-des-substances-chimiques/pesticides/documents/rapport-synthese/exposition-de-la-population-francaise-aux-substances-chimiques-de-l-environnement.-tome-1.-presentation-generale-de-l-etude.-metaux-et-metalloides>, accessed 1 February 2022. [French]
- FSA (2003). Safe upper levels for vitamins and minerals. Expert Group on Vitamins and Minerals, May 2003. London, UK: Food Standards Agency. <https://webarchive.nationalarchives.gov.uk/ukgwa/20121105225356/http://www.food.gov.uk/multimedia/pdfs/vitmin2003.pdf>, accessed 30 September 2022.
- Government of British Columbia (2019). Environmental management act, contaminated sites regulation B.C. Reg. 375/96. Victoria (BC), Canada: Government of British Columbia. Available from: https://www.bclaws.gov.bc.ca/civix/document/id/crbc/crbc/375_96_multi, accessed 30 September 2022.
- IFA (2021). Cobalt and its compounds. GESTIS International Limit Values database. Germany: Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (Institute for Occupational Safety and Health of the German Social Accident Insurance). Available from: <https://www.dguv.de/ifa/gestis/gestis-internationale-grenzwerte-fuer-chemische-substanzen-limit-values-for-chemical-agents/index-2.jsp>, accessed 30 September 2022.
- JSOH (2020). Recommendation of occupational exposure limits (2020–2021). *Environ Occup Health Practise*. 2(1): 1–34. doi:[10.1539/eohp.roel2020](https://doi.org/10.1539/eohp.roel2020)
- Klasson M, Bryngelsson IL, Pettersson C, Husby B, Arvidsson H, Westberg H (2016). Occupational exposure to cobalt and tungsten in the Swedish hard metal industry: air concentrations of particle mass, number, and surface area. *Ann Occup Hyg*. 60(6):684–99. PMID:[27143598](https://pubmed.ncbi.nlm.nih.gov/27143598/)
- Norwegian Scientific Committee for Food and Environment (2007). Risk assessment of health hazards from nickel, cobalt, zinc, iron, copper and manganese migrated from ceramic articles. Opinion of the Panel on Food Additives, Flavourings, Processing Aids, Materials in Contact with Food and Cosmetics of the Norwegian Scientific Committee for Food Safety, Adopted 2 May 2007. Oslo, Norway: Norwegian Scientific Committee for Food and Environment (Vitenskapskomiteen for mat og miljø). Available from: https://vkm.no/download/18_d44969415d027c43cf13da6/1501076192110/ebc8d55983.pdf, accessed 14 March 2022.

- NTP (2021). 15th report on carcinogens. Research Triangle Park (NC), USA: United States Department of Health and Human Services, Public Health Service. Available from: <https://doi.org/10.22427/NTP-OTHER-1003>, accessed 14 March 2022. doi:[10.22427/NTP-OTHER-1003](https://doi.org/10.22427/NTP-OTHER-1003)
- Ontario Ministry of Environment and Energy (1996). Scientific criteria document for the development of a provincial water quality objective for cobalt (stable isotope). PIBS 3361E. Toronto (ON), Canada: Ontario Ministry of Environment and Energy. Available from: <https://archive.org/details/cobaltscientific00torouoft>, accessed 1 February 2022.
- Saravanabhavan G, Werry K, Walker M, Haines D, Malowany M, Khoury C (2017). Human biomonitoring reference values for metals and trace elements in blood and urine derived from the Canadian Health Measures Survey 2007–2013. *Int J Hyg Environ Health*. 220(2 Pt A):189–200. doi:[10.1016/j.ijheh.2016.10.006](https://doi.org/10.1016/j.ijheh.2016.10.006) PMID:[27776932](https://pubmed.ncbi.nlm.nih.gov/27776932/)
- Scarselli A, Di Marzio D, Iavicoli S (2020). Assessment of exposure to cobalt and its compounds in Italian industrial settings. *Med Lav*. 111(1):22–31. PMID:[32096770](https://pubmed.ncbi.nlm.nih.gov/32096770/)
- Schmitz-Spanke S, Drexler H, Hartwig A, MAK Commission (2019). Addendum to cobalt and cobalt compounds [BAT value documentation, 2018]. In: The MAK-collection for occupational health and safety: annual thresholds and classifications for the workplace. Vol. 4, No. 3. Weinheim, Germany: Wiley-VCH Verlag GmbH Co. KGaA. Available from: [10.1002/3527600418.bb744048vere2319](https://doi.org/10.1002/3527600418.bb744048vere2319) doi:[10.1002/3527600418.bb744048vere2319](https://doi.org/10.1002/3527600418.bb744048vere2319)
- USGS (2021). US Geological Survey Minerals Yearbook 2019. Cobalt. Washington (DC), USA: United States Department of the Interior. Available from: <https://www.usgs.gov/centers/national-minerals-information-center/cobalt-statistics-and-information>, accessed 1 October 2021.
- Water Quality Australia (2018). Australian and New Zealand guidelines for fresh and marine water quality. Canberra (ACT), Australia: Department of Agriculture, Water and the Environment. Available from: <https://www.waterquality.gov.au/anz-guidelines>, accessed 1 February 2022.
- WHO (2006). Cobalt and inorganic cobalt compounds. Geneva, Switzerland: World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/43426/9241530693_eng.pdf?sequence=1&isAllowed=y<https://apps.who.int/iris/handle/10665/43426>, accessed 6 March 2022.