Princeton University LIBRARY

"If you can't grow it, you mine it"

Library Research for Critical Minerals, Conflict Minerals, and Rare Earths

GPO FDLP Webinar: June 17, 2021

Emily C. Wild, Chemistry, Geosciences and Environmental Studies Librarian
ewild@princeton.edu

https://www.usgs.gov/media/images/cobalt-ore

lithium-bearing clays and lithium brines

Colorado
https://manitousprings.org/mineral-spring-water/

https://www.mindat.org/element/Magnesium

https://www.usgs.gov/media/images/manganese-ore

Library User: "I spent two weeks searching for what you found in five minutes"

PRINCETON UNIVERSITY

Past GPO Presentations

"Princeton in the nation's service and the service of humanity"

Princeton University – GPO FDLP since 1884

Upcoming and Past Webinars:
https://libguides.princeton.edu/geo/librarianwebinars

USGS Library Materials for Earth's Age
https://www.fdlp.gov/usgs-library-materials-for-earth-s-age

USGS Library: Indexes, catalogs, and other bibliographic tools, a day in the life of a reference librarian https://www.fdlp.gov/usgs-library-indexes-catalogs-and-other-bibliographic-tools-a-day-in-the-life-of-a-reference-librarian

USGS Library: Oil, Gas, Coal, Uranium, and Minerals Maps and Data https://www.fdlp.gov/usgs-library-oil-gas-coal-uranium-and-minerals-maps-and-data

USGS Library: Using USGS Image, Map, and Data Products for Information Inquiries
https://www.fdlp.gov/usgs-library-using-usgs-image-map-and-data-products-for-information-inquiries

Thank You – Research Chemists & Geologists!!!!!!!

USGS Mineral Resources Program:
https://www.usgs.gov/energy-and-minerals/mineral-resources-program
USGS Geology, Geophysics, and Geochemistry Science Center: https://www.usgs.gov/centers/gggsc

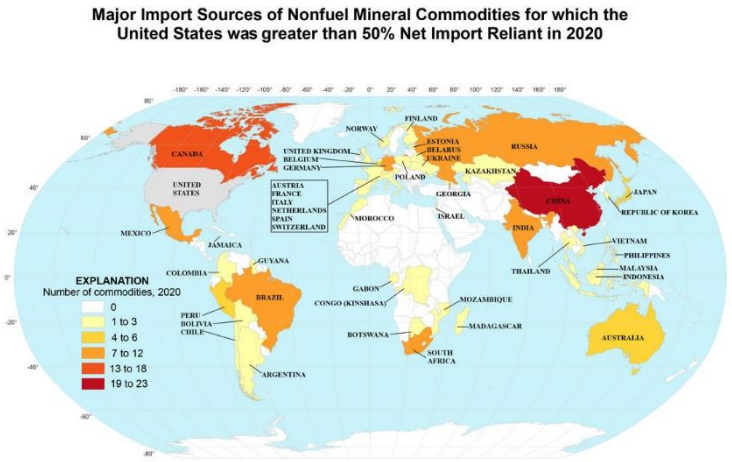
USGS Energy Resources Program:
https://www.usgs.gov/energy-and-minerals/energy-resources-program
USGS Central Energy Resources Science Center (CERSC)
https://www.usgs.gov/centers/cersc

USGS International Programs:
https://www.usgs.gov/about/organization/science-support/international-programs

International Geological Surveys:
Algeria, Afghanistan, United Arab Emirates, Saudi Arabia, Iraq, Australia, United Kingdom, Canada, Quebec, and France

Session Outline

- **Critical Minerals: Varied lists of critical minerals by country, can change**
- **Conflict Minerals: Can change through time**
- **Rare Earths: Actually, not really that rare, after all**
- **Environmental Research for Mining Activities: Before, During, After**



Source: U.S. Geological Survey https://pubs.er.usgs.gov/publication/mcs2021

Chemistry: Periodic Table of Elements
Geology: Minerals – Geologic processes forming

Working with Mineral Research Chemists & Geologists in:

- Worldwide Geological Surveys
- Mining Companies
- Mining Societies & Organizations
- Regulatory Agencies
- Universities/Colleges
- Indigenous Communities

In addition to Chemistry, Geosciences and Environmental Studies, Students I help looking for Minerals Research are also from : Politics, Policy, Engineering, Economics, Finance, Ecology & Evolutionary Biology, History, Chinese Studies, Art & Archeology, Anthropology
https://library.princeton.edu/staff/specialists

Where are the elements/minerals on Earth?

Who mines the elements/minerals on Earth?

Emily C. Wild

Princeton University Library

ewild@princeton.edu

Schedule a Research Consultation : Mon – Fri

Meet Our Specialists – Emily Wild

From hurricanes to astrogeology: Princeton's geosciences librarian and collections serve national, international communities

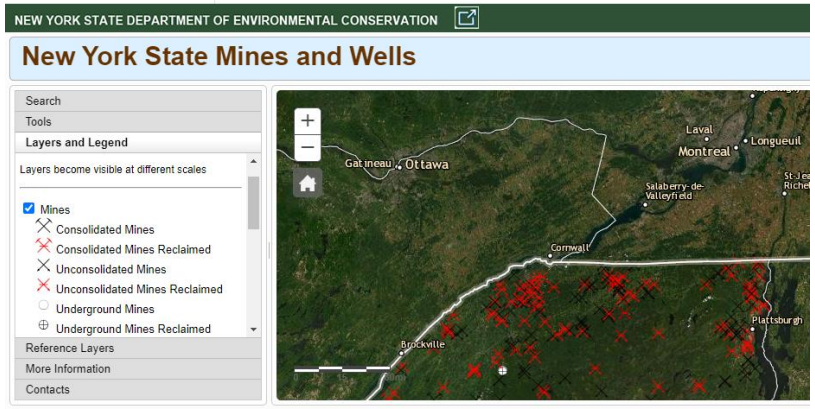
My personal investments are still within the USGS & Interior Ethics Guidelines : https://on.doi.gov/3hOdlpi

I follow ALA Code of Ethics, Privacy & Confidentiality : http://www.ala.org/tools/ethics

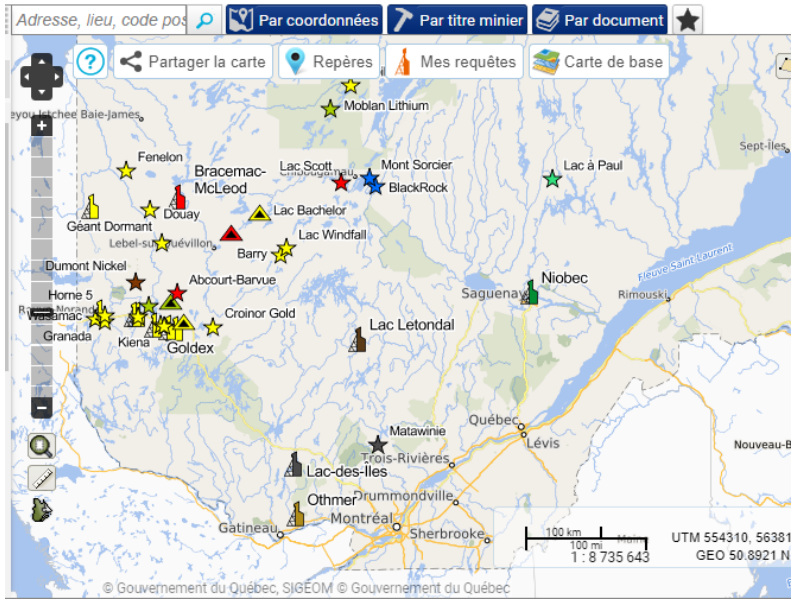
Princeton University Library, 2018-Present
Chemistry, Geosciences and Environmental Studies Librarian

U.S. Geological Survey: https://www.usgs.gov/staff-profiles/emily-wild
2008-2018 - Librarian (Physical Scientist): Denver, Colorado
1996-2008 – Hydrologist : [1998-2008 in Providence, Rhode Island]

I am from Northern New York along Québec border = English & French daily
During my childhood, my family spoke: French, Italian, German, Polish
Mining history from family: Québec, France, Poland, Germany, Italy



https://gisservices.dec.ny.gov/gis/maw/



https://mern.gouv.qc.ca/mines/

https://sigeom.mines.gouv.qc.ca/signet/classes/I1108_afchCarteIntr

Chemistry

https://library.princeton.edu/databases/subject/chemistry

Periodic Table of Elements

A Resource for Elementary, Middle School, and High School Students

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																		
1	1 H 1.008																	2 He 4.003
2	3 Li 6.94	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.79
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.96	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	*	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.5	81 Tl 204.38	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	**	104 Rf (265)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

Lanthanide Series*	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinide Series**	89 Ac (227)	90 Th 232	91 Pa 231	92 U 238	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

- Alkali metals
- Alkaline earth metals
- Transition metals
- Post-transition metals
- Metalloid
- Lanthanides
- Actinides
- Nonmetals
- Halogens
- Noble gases

Los Alamos National Laboratory
http://periodic.lanl.gov/

USGS Laboratories:
https://www.usgs.gov/usgs-laboratories

International Union of Pure and Applied Chemistry
Periodic Table of Elements
https://iupac.org/what-we-do/periodic-table-of-elements/

https://www.usgs.gov/news/ordinary-minerals-give-smartphones-extraordinary-capabilities

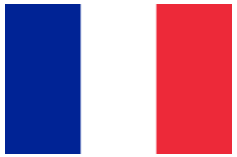
IUPAC Technical Report https://pubs.er.usgs.gov/search?q=IUPAC+Technical+Report

Ex. Chemistry from my childhood

https://en.gdch.de/service-information/year-of-the-pse/overview-of-the-periodic-table/general-information-about-the-periodic-table.html

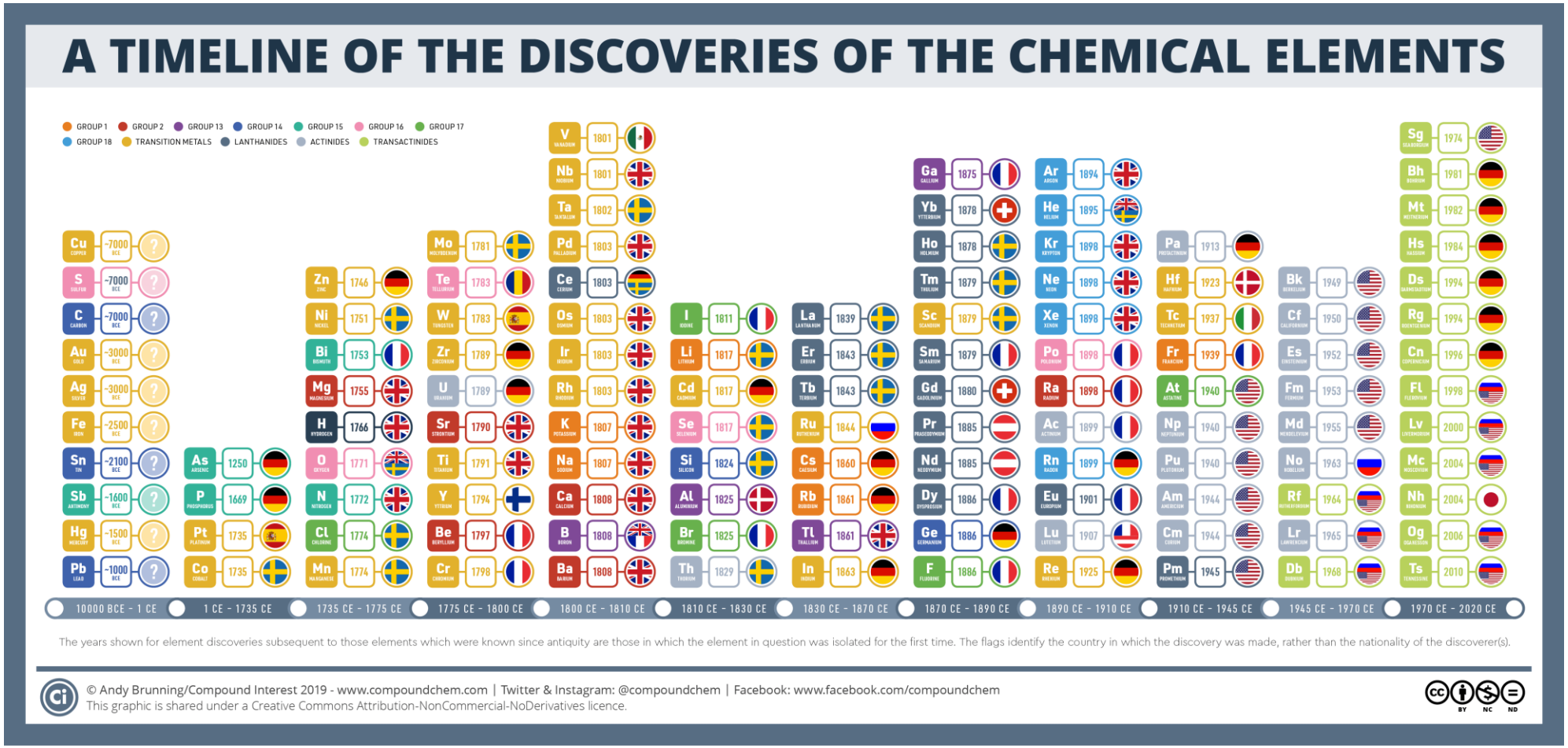
Periodic Table of Elements = Le tableau périodique des éléments = Periodensystem der Elemente

United States: ACS
https://www.acs.org/content/acs/en.html



France: Société Chimique de France
https://new.societechimiquedefrance.fr/

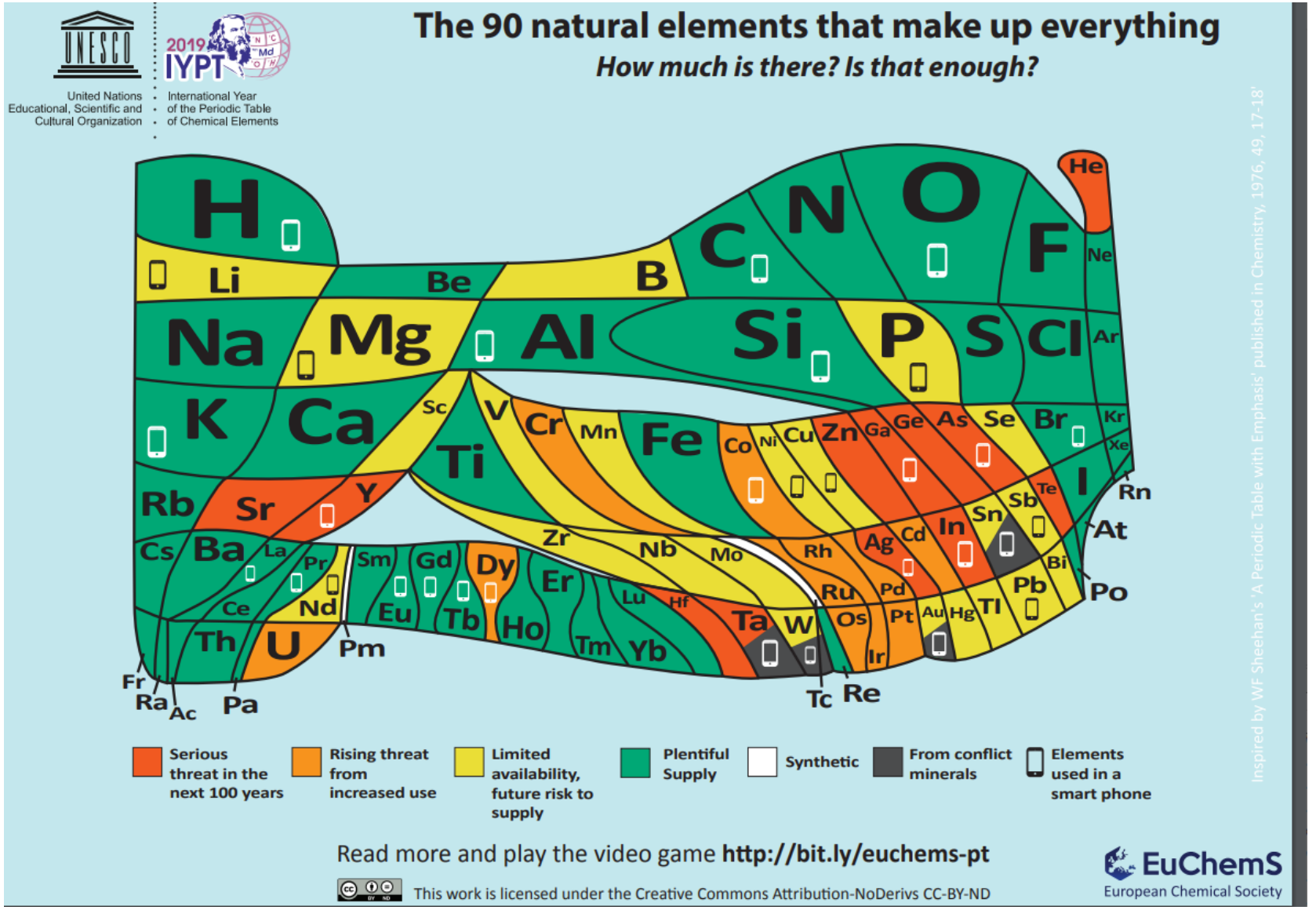
Germany: Gesellschaft Deutscher Chemiker (GDCh)
https://www.gdch.de/



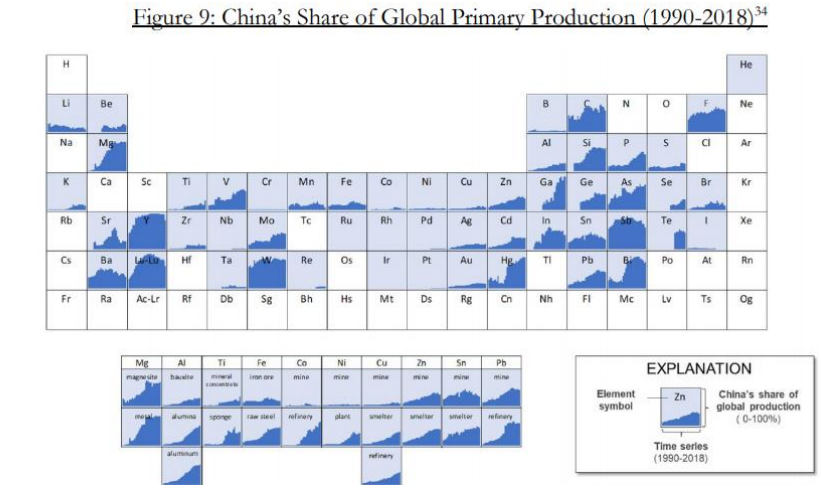
European Chemical Society: https://www.euchems.eu/euchems-periodic-table/

Chemistry

European Chemical Society: https://www.euchems.eu/euchems-periodic-table/
https://www.euchems.eu/wp-content/uploads/2018/10/Periodic-Table-ultimate-PDF.pdf



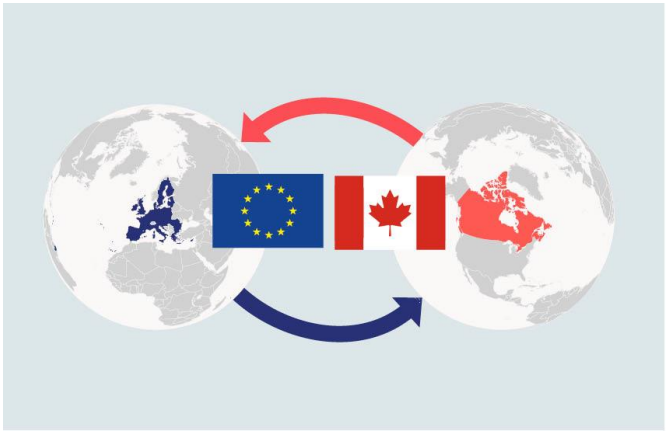
Why do I help researchers with Critical Minerals? In the News:



https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf

Murkowski Raises Domestic Critical Mineral Supply Chain to Secretary of Energy

MISSOURI DEPARTMENT OF NATURAL RESOURCES AWARDED GRANT FOR INITIATIVE TO ASSESS RARE EARTH ELEMENTS AND CRITICAL MINERALS



"Invest in sustainable domestic and international production and processing of critical minerals"

French mining company Eramet and local utility Électricité de Strasbourg (ÉS) successfully extract lithium from geothermal brine in Alsace, France.

EU-Canada summit, Brussels, 14 June 2021

To diversify sources of important green and digital economy inputs away from less like-minded producers, and to foster competitive EU-Canada supply chains, the leaders established an **EU-Canada Strategic Partnership on Raw Materials.**
https://www.consilium.europa.eu/en/meetings/international-summit/2021/06/14/
The leaders announced a new strategic partnership on raw materials to help ensure the security of supply chains for the critical minerals and metals that are essential to the transition to a cleaner and digitized economy, including for use in electric vehicles and advanced battery storage.
https://pm.gc.ca/en/news/news-releases/2021/06/15/prime-minister-concludes-productive-canada-european-union-summit

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) First test of a manganese nodule collector in around four kilometers of water: research consortium successfully completes monitoring of environmental impacts in the Pacific

First posted May 7, 2021: Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List https://pubs.er.usgs.gov/publication/ofr20211045

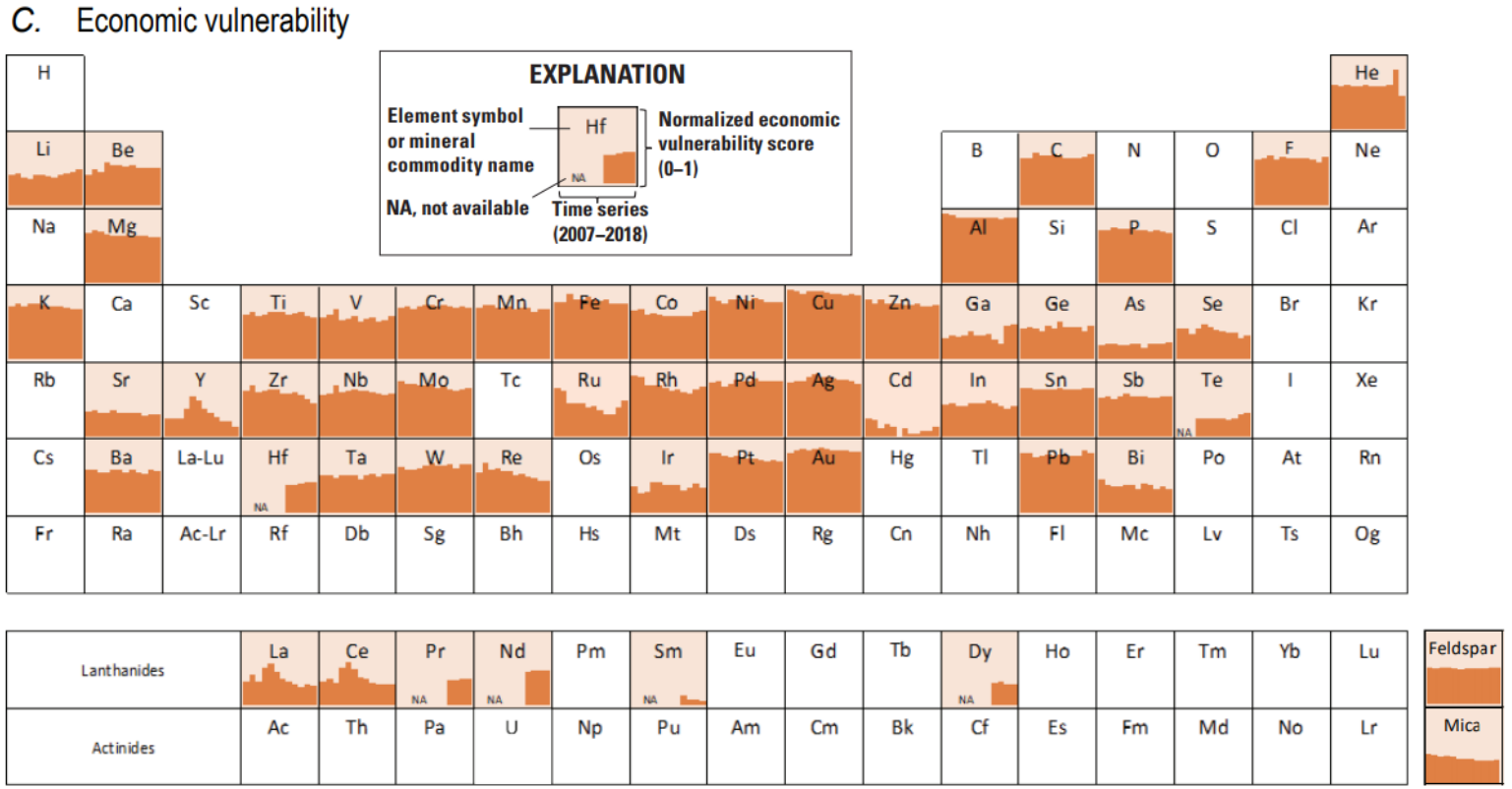


Figure 1. Supply risk indicators for selected mineral commodities from 2007 through 2018. For the 54 mineral commodities assessed (shaded areas) for the period 2007 through 2018, time-series evaluations of the following supply risk indicators are displayed on a periodic table of the elements: A, disruption potential; B, trade exposure; C, economic vulnerability; and D, overall supply risk for 2007 through 2018. Normalized indicator scores range from 0 to 1, with higher scores indicating a greater degree of disruption potential, trade exposure, economic vulnerability, or supply risk. For some commodities, indicator scores are rounded to avoid disclosing company proprietary data. The scores for graphite and fluorspar are provided under carbon ("C") and fluorine ("F"), respectively, and because no one element is associated with mica or feldspar, these mineral commodities are shown separately. Element symbols are defined in the periodic table provided in the front of the report.

Page 12:
Comparison to the Initial Critical Minerals List

The list of mineral commodities that are recommended for inclusion on the CML in this analysis (and the basis for that recommendation) is provided and compared to those on the initial CML in table 2.

[Interior Releases 2018's Final List of 35 Minerals Deemed Critical to U.S. National Security and the Economy]

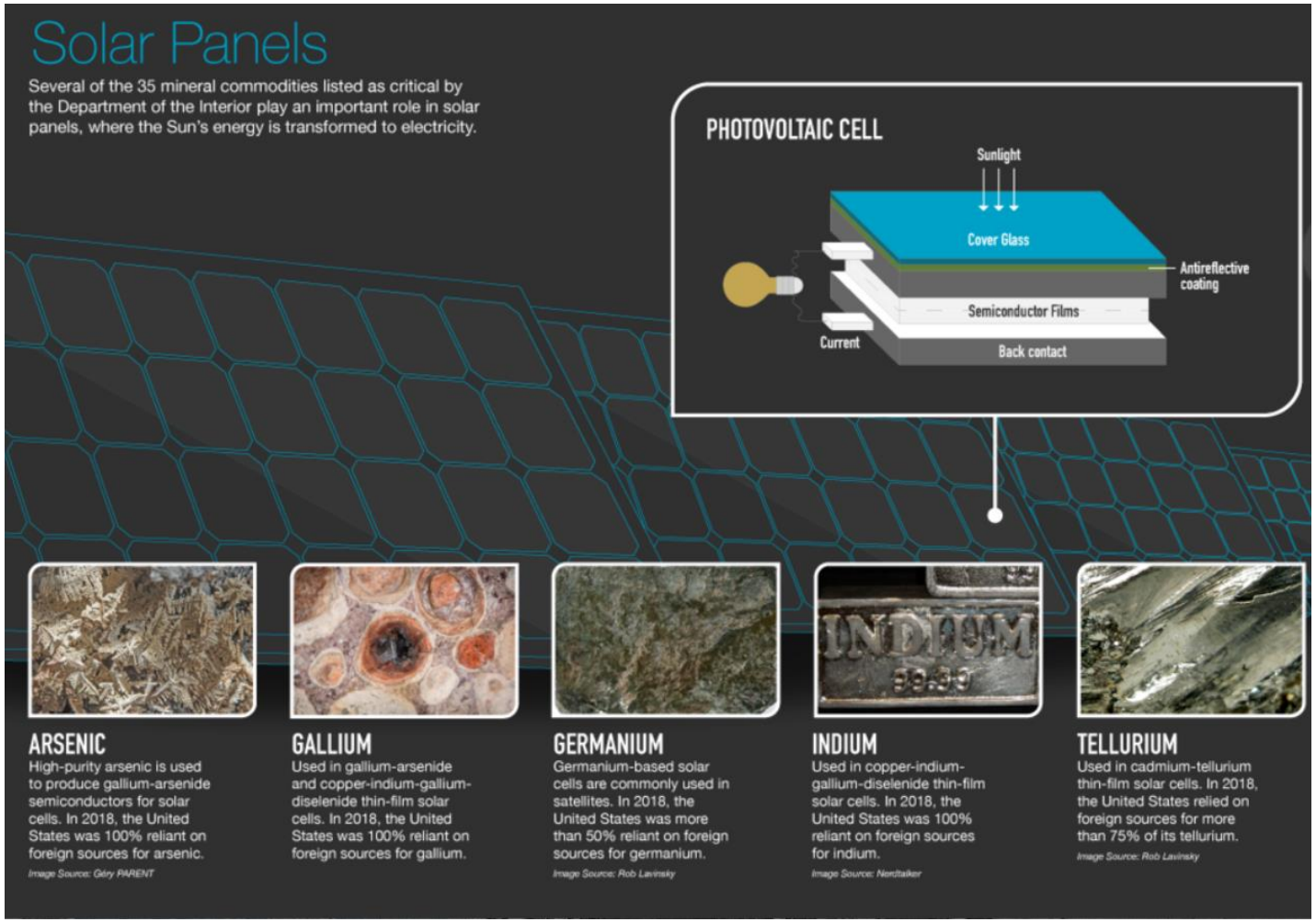
35 Critical Minerals – United States

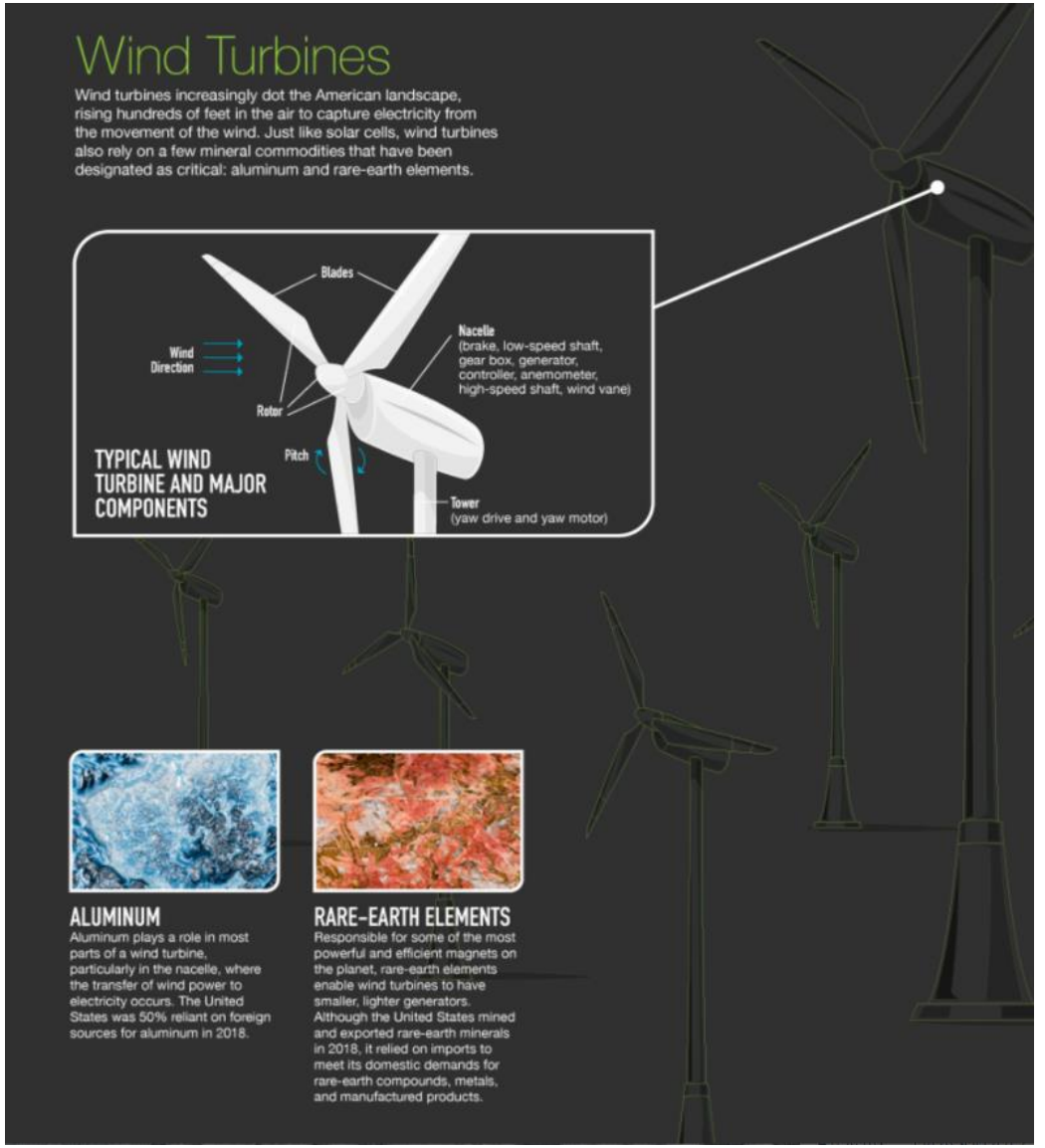
Interior Releases 2018's Final List of 35 Minerals Deemed Critical to U.S. National Security and the Economy
https://www.usgs.gov/news/interior-releases-2018-s-final-list-35-minerals-deemed-critical-us-national-security-and

- Aluminum (bauxite), used in almost all sectors of the economy
- Antimony, used in batteries and flame retardants
- Arsenic, used in lumber preservatives, pesticides, and semi-conductors
- Barite, used in cement and petroleum industries
- Beryllium, used as an alloying agent in aerospace and defense industries
- Bismuth, used in medical and atomic research
- Cesium, used in research and development
- Chromium, used primarily in stainless steel and other alloys
- Cobalt, used in rechargeable batteries and superalloys
- Fluorspar, used in the manufacture of aluminum, gasoline, and uranium fuel
- Gallium, used for integrated circuits and optical devices like LEDs
- Germanium, used for fiber optics and night vision applications
- Graphite (natural), used for lubricants, batteries, and fuel cells
- Hafnium, used for nuclear control rods, alloys, and high-temperature ceramics
- Helium, used for MRIs, lifting agent, and research
- Indium, mostly used in LCD screens
- Lithium, used primarily for batteries
- Magnesium, used in furnace linings for manufacturing steel and ceramics
- Manganese, used in steelmaking
- Niobium, used mostly in steel alloys
- Platinum group metals, used for catalytic agents
- Potash, primarily used as a fertilizer
- Rare earth elements group, primarily used in batteries and electronics
- Rhenium, used for lead-free gasoline and superalloys
- Rubidium, used for research and development in electronics
- Scandium, used for alloys and fuel cells
- Strontium, used for pyrotechnics and ceramic magnets
- Tantalum, used in electronic components, mostly capacitors
- Tellurium, used in steelmaking and solar cells
- Tin, used as protective coatings and alloys for steel
- Titanium, overwhelmingly used as a white pigment or metal alloys
- Tungsten, primarily used to make wear-resistant metals
- Uranium, mostly used for nuclear fuel
- Vanadium, primarily used for titanium alloys
- Zirconium, used in the high-temperature ceramics industries

Why do I help researchers with Critical Minerals?

https://www.usgs.gov/media/images/critical-mineral-commodities-renewable-energy





Why do I help researchers with Critical Minerals?

https://www.usgs.gov/media/images/critical-mineral-commodities-renewable-energy

Batteries

Batteries play an important supporting role for renewable energy sources like wind and solar, allowing excess power to be stored for usage when direct solar or wind power are unavailable. Just like the energy sources they complement, modern batteries rely on critical mineral commodities, particularly cobalt, graphite, lithium, and manganese.

COBALT

On a global basis, the leading use of cobalt is in rechargeable battery electrodes. In 2018, the United States relied on foreign sources for 61% of the cobalt it consumed.

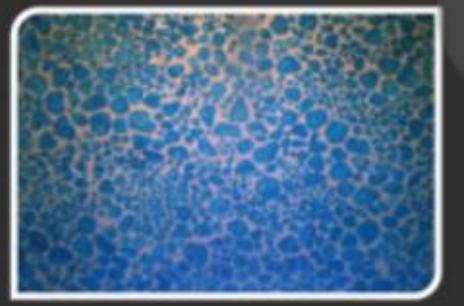
Image Source: James St. John

GRAPHITE

Graphite serves as an electrode in many lithium batteries. In 2018, the United States was 100% reliant on foreign sources for graphite.

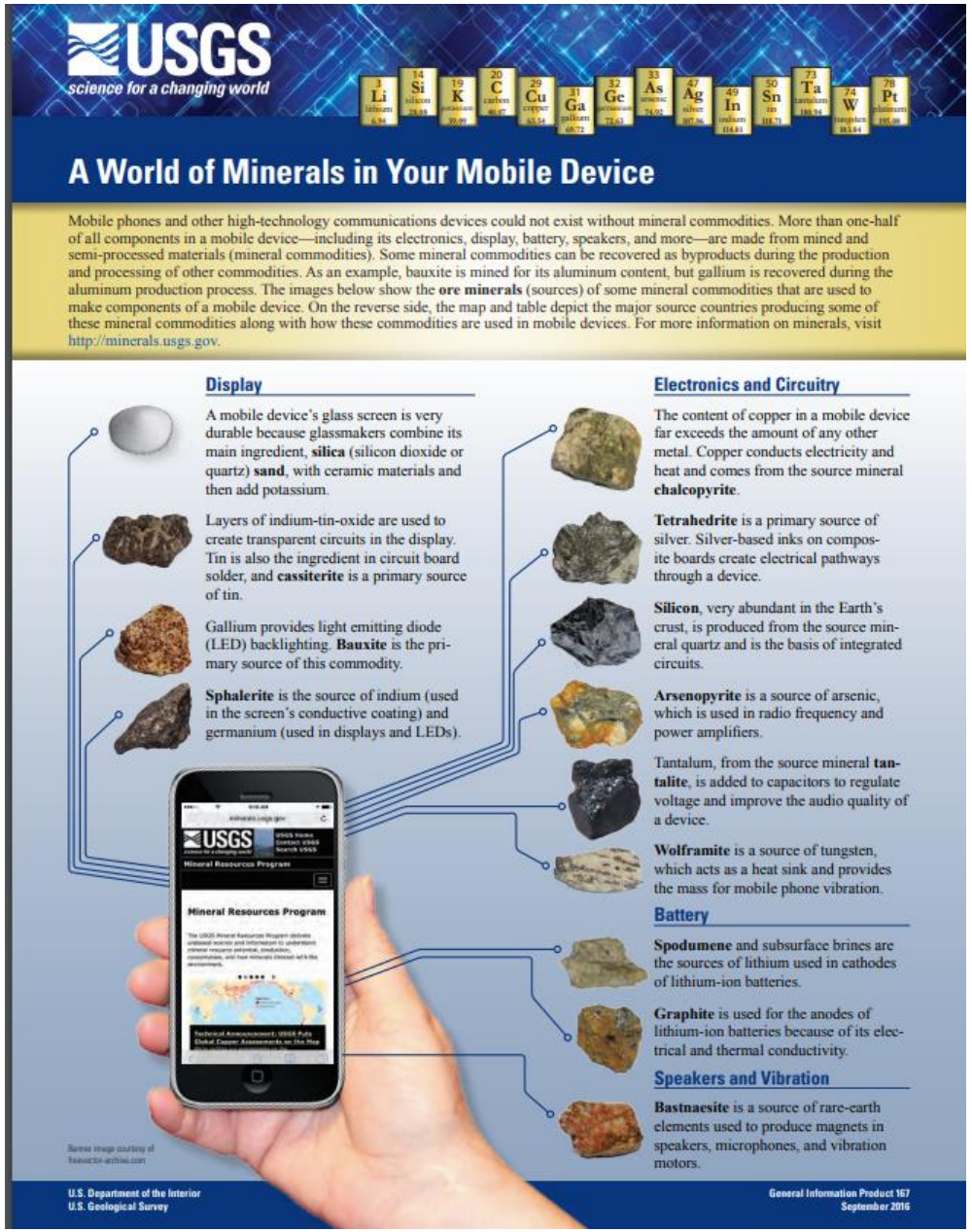
LITHIUM

Lithium has a long history in batteries and is a common material used in batteries today. In 2018, the United States was more than 50% reliant on foreign sources for lithium.

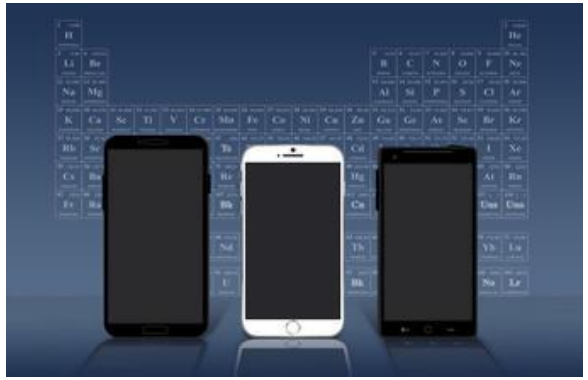


MANGANESE

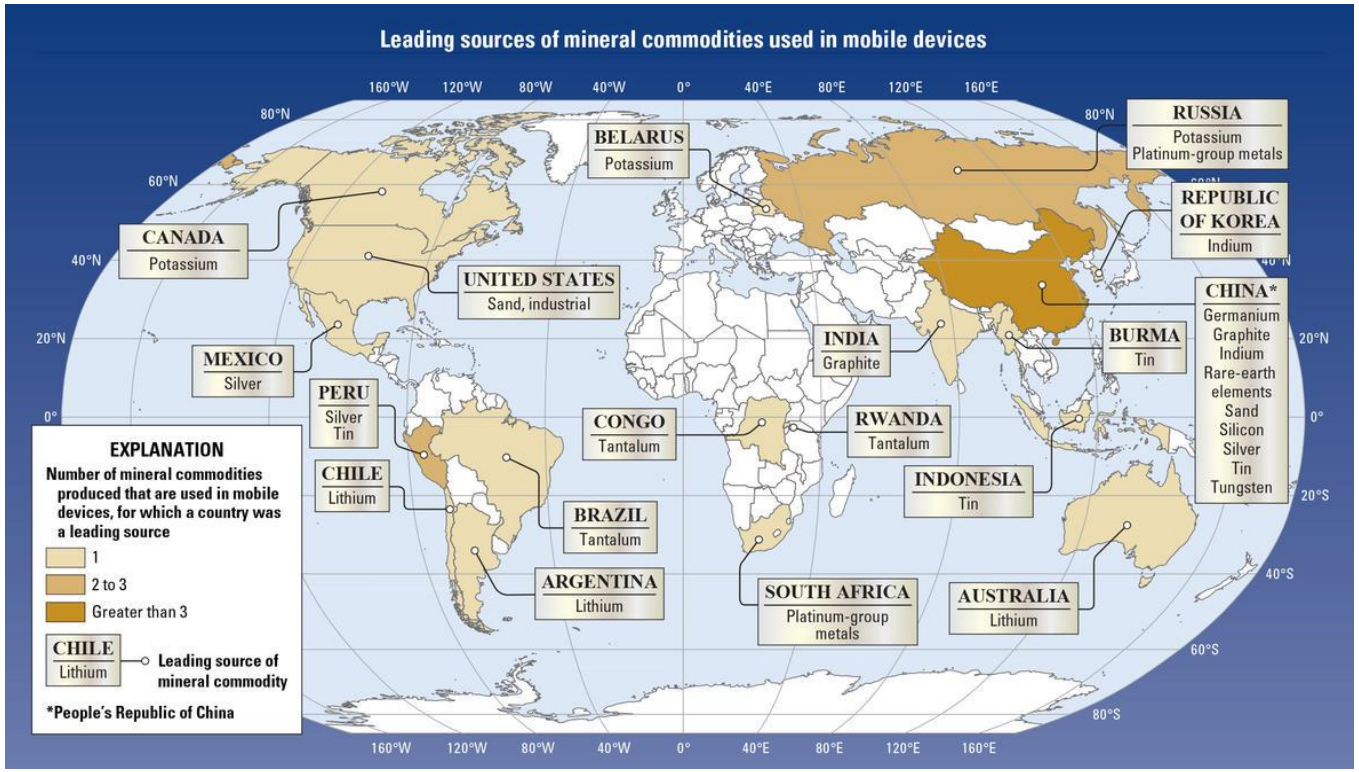
Manganese serves as an electrode in many lithium batteries. The United States was 100% reliant on foreign sources for manganese in 2018.



https://pubs.usgs.gov/gip/0167/gip167.pdf



Australia, Chile, and Argentina often produce the lithium used in battery cathodes, while the hard-to-come-by tantalum – used in smartphone circuitry – mostly comes from Congo, Rwanda, and Brazil.



https://www.usgs.gov/news/ordinary-minerals-give-smartphones-extraordinary-capabilities

USGS Publications

- 2017: Critical mineral resources of the United States—Economic and environmental geology and prospects for future supply https://pubs.er.usgs.gov/publication/pp1802
- 2021: Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List https://pubs.er.usgs.gov/publication/ofr20211045
- 2018: Draft critical mineral list—Summary of methodology and background information—U.S. Geological Survey technical input document in response to Secretarial Order No. 3359 https://pubs.er.usgs.gov/publication/ofr20181021

Lithium:
https://pubs.er.usgs.gov/publication/pp1802K
"Lithium, the lightest of all metals, is used in air treatment, batteries, ceramics, glass, metallurgy, pharmaceuticals, and polymers."

Manganese:
https://pubs.er.usgs.gov/publication/pp1802L
"Manganese is an essential element for modern industrial societies. Its principal use is in steelmaking, where it serves as a purifying agent in iron-ore refining and as an alloy that converts iron into steel. "

https://pubs.er.usgs.gov/search?q=critical+minerals

https://library.princeton.edu/find/all/USGS%202020%20CRITICAL%20MINERALS%20REVIEW

"Emily's helping mineral researchers cycle"

I help Chemists & Geologists prior to publication

I help researchers find the publication & data when published through outreach & instruction events

I help mining companies and investors find the references & data within the publication (NYC, Princeton, Alumni, …)

I help geologists find data and new research published since this publication

Geological Surveys Worldwide

https://www.gsj.jp/en/gsj-link/directory/index.html
https://www.gsj.jp/en/gsj-link/directory/dir-gse.html

Geological Surveys Worldwide

https://www.gsj.jp/en/gsj-link/directory/index.html
https://www.gsj.jp/en/gsj-link/directory/dir-gse.html


Canada

Geological Survey of Canada, Ottawa (Headquarters)
https://www.nrcan.gc.ca/science-data/research-centres-labs/geological-survey-canada/17100

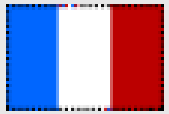
Ontario Geological Survey (OGS) http://www.geologyontario.mndm.gov.on.ca
Ministère de l'Énergie et des Ressources naturelles (MERN) https://mern.gouv.qc.ca/
Alberta Geological Survey (AGS) http://ags.aer.ca
British Columbia Geological Survey (BCGS) http://www.em.gov.bc.ca/geology/
Manitoba Geological Survey (MGS) http://www.manitoba.ca/iem/geo/
New Brunswick Minerals and Petroleum http://www.gnb.ca/0078/minerals
Geological Survey Division of Newfoundland and Labrador http://www.nr.gov.nl.ca/nr
Northwest Territories Geological Survey http://www.nwtgeoscience.ca/
Nova Scotia Mineral Resources Branch http://www.gov.ns.ca/natr/meb/
Prince Edward Island Energy and Minerals Unit http://www.gov.pe.ca/development/eam-info/index.php3
Saskatchewan Geological Survey http://www.economy.gov.sk.ca/
Yukon Geological Survey (YGS) http://geology.gov.yk.ca/

Geological Surveys Worldwide

https://www.gsj.jp/en/gsj-link/directory/index.html
https://www.gsj.jp/en/gsj-link/directory/dir-gse.html

http://www.brgm.fr/

http://www.ifremer.fr/



France

Bureau de Recherches Géologiques et Minières (BRGM)
3, Avenue Claude Guillemin, B.P. 6009, F-45060, Orléans Cedex 2
Phone: +33-2 38 64 34 34
Fax: +33-2 38 64 35 18
WWW Page: http://www.brgm.fr/

French Research Institute for Exploitation of the Sea (IFREMER) (Institut Français de Recherche pour l'Exploitation de la Mer)
Technopole de Brest-Iroise, BP 70 29280 PLOUZANE
Phone: +33-2-98224040
Fax: +33-2-98224545
WWW Page: http://www.ifremer.fr/

Geological Surveys Worldwide

https://www.gsj.jp/en/gsj-link/directory/index.html
https://www.gsj.jp/en/gsj-link/directory/dir-gse.html

Germany

Federal Institute of Geoscience and Natural Resources (BGR) (Bundesanstalt für Geowissenschaften und Rohstoffe)
Geozentrum Hannover, Stilleweg 2, D-30655 Hannover
Phone: +49-511-643-0
Fax: +49-511-643-2304
Email: poststelle@bgr.de
WWW Page: http://www.bgr.bund.de/

Alfred Wegener Institute Helmholtz Center for Polar and Marine Research (AWI) (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung)
Am Handelshafen 12, 27570 Bremerhaven
Phone: +49-471-4831-0
Fax: +49-471-4831-1149
WWW Page: https://www.awi.de/en.html

Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences (GFZ) (Helmholtz Zentrum Potsdam - Deutsches GeoForschungsZentrum GFZ)
Telegrafenberg, D-14473 Potsdam
Phone: +49-331-288-0
Fax: +49-331-288-1044
WWW Page: http://www.gfz-potsdam.de/

GEOMAR Helmholtz Centre for Ocean Research Kiel
Wischhofstrasse 1-3, D-24148 Kiel
Phone: +49-431-600-0
Fax: +49-431-600-2805
Email: info@geomar.de
WWW Page: http://www.geomar.de/en/

http://www.bgr.bund.de/

https://www.awi.de/en.html

http://www.gfz-potsdam.de/

http://www.geomar.de/en/

U.S. Geological Survey

https://pubs.er.usgs.gov
https://pubs.er.usgs.gov/browse/Report/USGS%20Unnumbered%20Series/
https://pubs.er.usgs.gov/browse/Report/USGS%20Numbered%20Series/

Mineral commodity summaries 2021, 2021, Mineral Commodity Summaries
Minerals Yearbook, volume III, Area Reports—International—Latin America and Canada, 2018, Minerals Yearbook (III) -
Minerals Yearbook, volume III, Area Reports—International—Europe and Central Eurasia, 2018, Minerals Yearbook (III) -
Minerals Yearbook, volume III, Area Reports—International—Asia and the Pacific, 2018, Minerals Yearbook (III) -
Minerals Yearbook, volume III, Area Reports—International—Africa and the Middle East, 2018, Minerals Yearbook (III) -
Minerals Yearbook, volume I, Metals and Minerals, 2018, Minerals Yearbook (I) -
Minerals Yearbook, volume II, Area Reports—Domestic, 2018, Minerals Yearbook (II) -
Minerals Yearbook, volume III, Area Reports—International, 2018, Minerals Yearbook (III) -

By Country: https://www.usgs.gov/centers/nmic/international-minerals-statistics-and-information
Algeria - Map (GIF) (Key)
The Mineral Industry of Algeria PDF Format:
| 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |

https://www.usgs.gov/centers/nmic/mineral-commodity-summaries
Helium PDF Format:
| 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |

U.S. Geological Survey

https://pubs.er.usgs.gov
https://pubs.er.usgs.gov/browse/Report/USGS%20Unnumbered%20Series/
https://pubs.er.usgs.gov/browse/Report/USGS%20Numbered%20Series/

World Mine Production and Reserves: Reserves for multiple countries were revised based on industry reports.

	Mine production		Reserves[8]
	2019	2020[e]	
United States	500	600	53,000
Australia	5,740	5,700	[9]1,400,000
Canada	3,340	3,200	220,000
China	2,500	2,300	80,000
Congo (Kinshasa)	100,000	95,000	3,600,000
Cuba	3,800	3,600	500,000
Madagascar	3,400	700	100,000
Morocco	2,300	1,900	14,000
Papua New Guinea	2,910	2,800	51,000
Philippines	5,100	4,700	260,000
Russia	6,300	6,300	250,000
South Africa	2,100	1,800	40,000
Other countries	6,320	6,400	560,000
World total (rounded)	144,000	140,000	7,100,000

https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-cobalt.pdf

Congo (Kinshasa)

https://pubs.er.usgs.gov/publication/pp1802F
https://pubs.er.usgs.gov/search?q=Democratic+Republic+of+the+Congo

Cobalt - Responsible Minerals Initiative/

Cobalt Statistics and Information

https://www.usgs.gov/centers/nmic/cobalt-statistics-and-information

Mineral Industry Surveys

Cobalt

PDF Format:

2021: | Jan | Feb | Mar |

2020: | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |

Mineral Commodity Summaries

Cobalt

PDF Format:

| 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |

Minerals Yearbook

Cobalt

PDF Format:

| 1994 | 1994 (figures) | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |

U.S. Geological Survey

https://pubs.er.usgs.gov
https://pubs.er.usgs.gov/browse/Report/USGS%20Unnumbered%20Series/
https://pubs.er.usgs.gov/browse/Report/USGS%20Numbered%20Series/

Lithium: https://www.usgs.gov/centers/nmic/lithium-statistics-and-information

Mineral Commodity Summaries

•Lithium

PDF Format:

| 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |

•Appendixes

World Mine Production and Reserves: Reserves for Argentina, Australia, Canada, Chile, China, the United States, Zimbabwe, and other countries were revised based on new information from Government and industry sources.

	Mine production 2019	Mine production 2020[e]	Reserves[5]
United States	W	W	750,000
Argentina	6,300	6,200	1,900,000
Australia	45,000	40,000	[6]4,700,000
Brazil	2,400	1,900	95,000
Canada	200	—	530,000
Chile	19,300	18,000	9,200,000
China	10,800	14,000	1,500,000
Portugal	900	900	60,000
Zimbabwe	1,200	1,200	220,000
Other countries[7]	—	—	2,100,000
World total (rounded)	[8]86,000	[8]82,000	21,000,000

Australia: https://www.ga.gov.au/

Minerals Yearbook

Lithium

PDF Format:

| 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |

Lithium--For Harnessing Renewable Energy

Fact Sheet 2014-3035

Lithium use in batteries

Circular 1371

https://pubs.er.usgs.gov/publication/pp1802K

U.S. Geological Survey

https://pubs.er.usgs.gov
https://pubs.er.usgs.gov/browse/Report/USGS%20Unnumbered%20Series/
https://pubs.er.usgs.gov/browse/Report/USGS%20Numbered%20Series/

Niobium (Columbium) and Tantalum Statistics and Information
https://www.usgs.gov/centers/nmic/niobium-columbium-and-tantalum-statistics-and-information

Mineral Commodity Summaries
Tantalum PDF Format:
| 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |

Minerals Yearbook Tantalum PDF Format:
| 2015 | 2016 | 2017 |

Conflict Minerals from the Democratic Republic of the Congo--Global Tantalum Processing Plants, a Critical Part of the Tantalum Supply Chain
Fact Sheet 2014-3122

World Mine Production and Reserves: Reserves for Australia and Brazil were revised based on Government and industry information.

	Mine production 2019	Mine production 2020[e]	Reserves[8]
United States	—	—	—
Australia	67	30	[9]99,000
Brazil	430	370	40,000
Burundi	38	30	NA
China	76	70	NA
Congo (Kinshasa)	580	670	NA
Ethiopia	70	60	NA
Nigeria	180	160	NA
Russia	26	26	NA
Rwanda	336	270	NA
Other countries	45	35	NA
World total (rounded)	1,850	1,700	>140,000

World Resources:[8] Identified world resources of tantalum, most of which are in Australia, Brazil, and Canada, are considered adequate to supply projected needs. The United States has about 55,000 tons of tantalum resources in identified deposits, most of which were considered uneconomical at 2020 prices for tantalum.

http://www.responsiblemineralsinitiative.org/minerals-due-diligence/tantalum/

Tantalum is extensively used in products that require high reliability in extreme environments. The metal is commonly found in capacitors and super alloys that are applied in many electronics, automotive and aerospace products. More than half of the world's tantalum is mined in Africa, including artisanal mining operations in the Democratic Republic of the Congo (DRC) and its neighboring countries. Tantalum is covered by regulations related to "conflict minerals" in the United States and the European Union.

U.S. Geological Survey +

https://pubs.er.usgs.gov/publication/ofr20211049

Deposit Classification Scheme for the Critical Minerals Mapping Initiative Global Geochemical Database

Prepared as part of a joint research program between the U.S. Geological Survey, Geological Survey of Canada, Geological Survey of Queensland, and Geoscience Australia

First posted June 4, 2021

A challenge for the global economy is to meet the growing demand for commodities used in today's advanced technologies. Critical minerals are commodities (for example, elements, compounds, minerals) deemed vital to the economic and national security of individual countries that are vulnerable to supply disruption. The national geological agencies of Australia, Canada, and the United States recently joined forces to advance understanding and foster development of critical mineral resources in their respective countries through the Critical Minerals Mapping Initiative (CMMI). An initial goal of the CMMI is to fill the knowledge gap on the abundance of critical minerals in ores. To do this, the CMMI compiled modern multielement geochemical data generated by each agency on ore samples collected from historical and active mines and prospects from around the world. To identify relationships between critical minerals, deposit types, deposit environments, and mineral systems, a unified deposit classification scheme was needed. This report describes the scheme developed by the CMMI to classify the initial release of geochemical data. In 2021, the resulting database—along with basic query, statistical analysis, and display tools—will be served to the public through a web-based portal managed by Geoscience Australia. The database will enable users to trace critical minerals through mineral systems and identify individual deposits or deposit types that are potential sources of critical minerals.

Critical Minerals Mapping Initiative Forum

Monday, June 28, 2021 3:00 PM EDT | 2 hours

Register

Series: Critical Minerals Mapping Initiative

Organized by the Geological Survey of Canada, Geoscience Australia, and the United States Geological Survey, and hosted by the American Geosciences Institute

https://www.americangeosciences.org/webinars/critical-minerals-mapping-initiative-forum

U.S. Geological Survey

***Vic worked down the hall from the USGS Denver Library & he introduced me to visiting researchers & referred researchers from international geological surveys & societies: Australia, Canada, France, Iraq, Japan, Venezuela, and many others…**

2016 - Underpinning Innovation: The Science and Supply of America's Critical Minerals and Materials

Society of Exploration Geophysicists
https://library.seg.org/doi/10.1190/tle40020155.1

Geological Surveys Unite to Improve Critical Mineral Security
https://eos.org/science-updates/geological-surveys-unite-to-improve-critical-mineral-security

Advances in critical mineral research: A forum in memory of Victor Labson

Organized by the Geological Survey of Canada, Geoscience Australia, and the United States Geological Survey

Sponsored by the World Community of Geological Surveys and hosted by the American Geosciences Institute

https://www.americangeosciences.org/webinars/critical-minerals-forum-2021

https://www.youtube.com/playlist?list=PLTBBygdCOWWc3qmnd31sktvs8UxD_oTG6

27 videos:

Americas: United States Geological Survey, Geological Survey of Canada, Québec Ministère de l'Énergie et des Ressources Naturelles, Servicio Geológico Mexicano, Servicio Nacional de Geología y Minería (Chile), Serviço Geológico do Brasil

Europe and Africa: Laboratório Nacional de Energia e Geologia and Instituto Geológico y Minero de España (Portugal and Spain), Geologian Tutkimuskeskus (Finland), British Geological Survey (United Kingdom), Bureau de Recherches Géologiques et Minières (France), Botswana Geoscience Institute (Botswana), Council for Geoscience (South Africa)

Asia and Oceania Session: Geoscience Australia, Coordinating Committee for Geoscience Programmes in East and Southeast Asia (Thailand), Korea Institute of Geoscience and Mineral Resources, GNS (New Zealand) Geological Survey of Queensland (Australia), Geological Survey of India

U.S. Geological Survey

https://www.usgs.gov/usgs-laboratories

The USGS has over 500 laboratories nationwide. Those with active sites are listed here, with many more coming online over the coming year.

Reston Stable Isotope Laboratory: https://isotopes.usgs.gov/
Isotopic Reference Materials
https://isotopes.usgs.gov/research/topics/isotopereferencematerials.html
Isotope-Ratio Reporting Guidelines https://isotopes.usgs.gov/research/topics/reportingguidlines.html
https://www.usgs.gov/staff-profiles/tyler-b-coplen

Reference Materials and Calibration Services
https://isotopes.usgs.gov/lab/referencematerials.html

Instructions for Collecting Samples
https://isotopes.usgs.gov/lab/instructions.html

Methods & SOPs
https://isotopes.usgs.gov/lab/methods.html

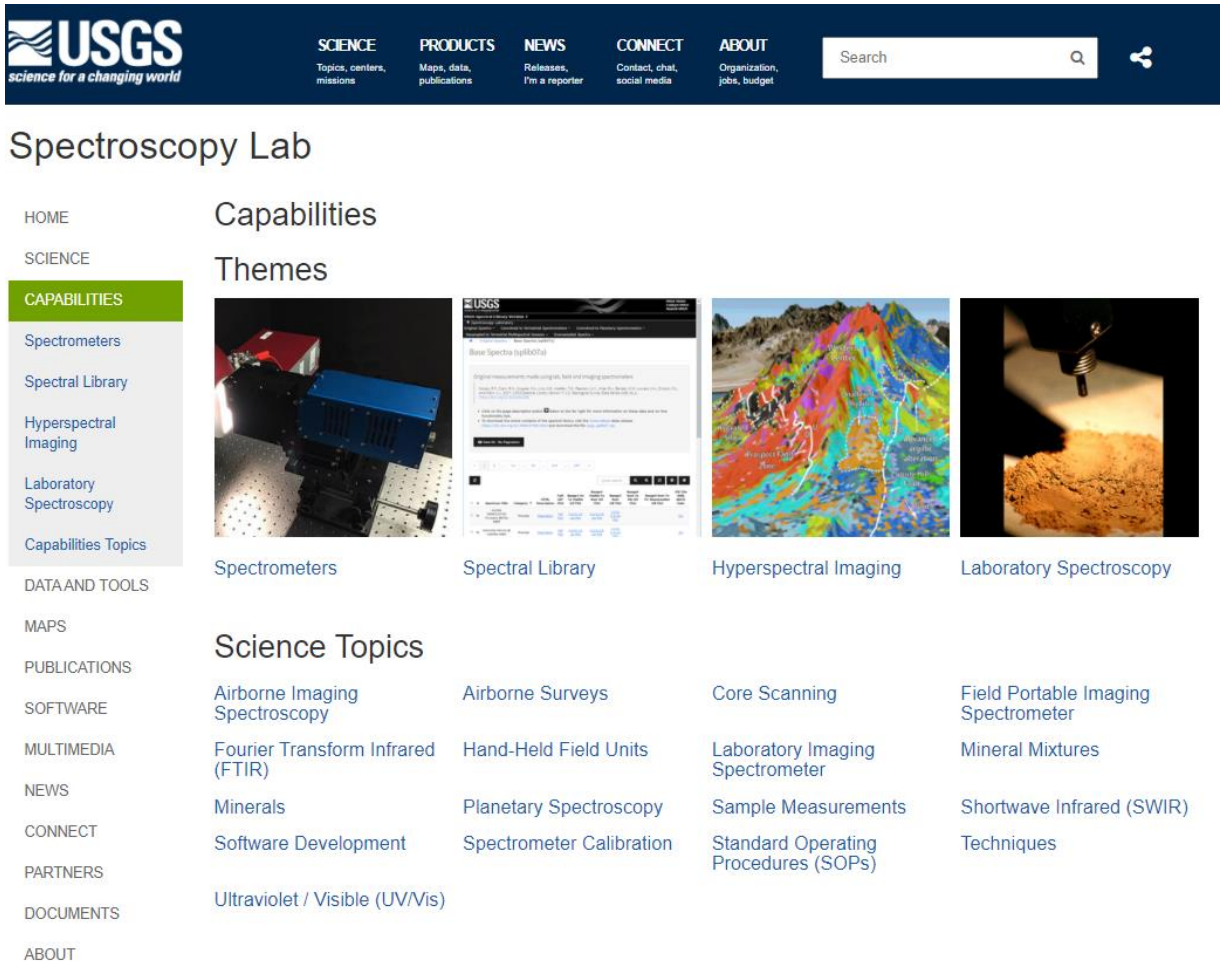
U.S. Geological Survey

https://www.usgs.gov/usgs-laboratories

Colorado Laboratories:

Spectroscopy Lab https://www.usgs.gov/labs/spec-lab

Software: https://www.usgs.gov/labs/spec-lab/software



Mineralogy and Microscopy Laboratory

The Mineralogy and Microscopy Laboratory in the Geosciences and Environmental Change Science Center, Denver Colorado, supports the investigation of mineralogical components of sediments and whole roc materials. https://www.usgs.gov/centers/gecsc/labs/mineralogy-and-microscopy-laboratory

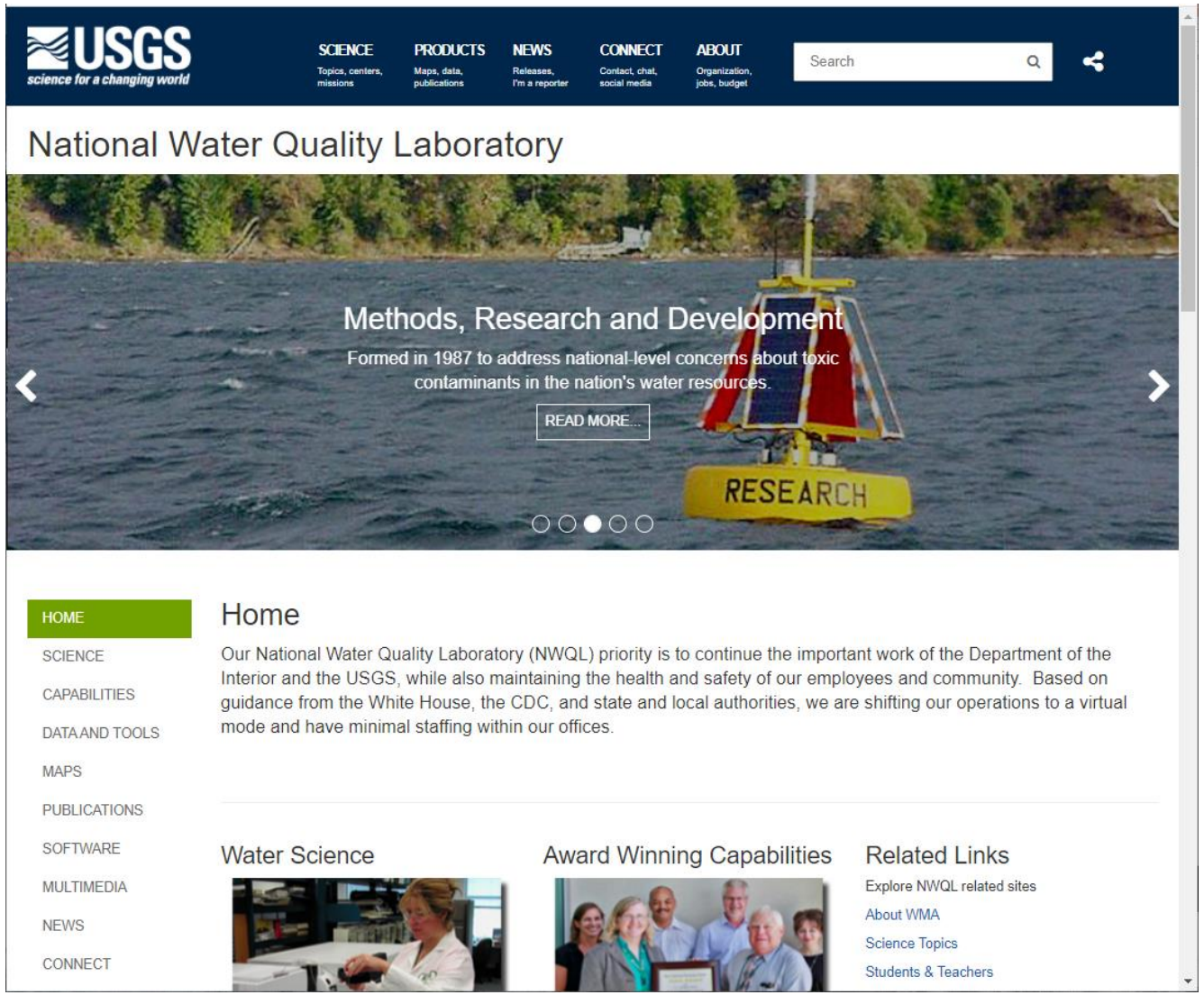
USGS TRIGA Reactor

https://www.usgs.gov/core-science-systems/crc/gstr

The USGS TRIGA® Reactor (GSTR) is a low–enriched uranium–fueled, pool–type reactor. The mission of the TRIGA® is to support USGS scien by providing information on geologic, plant, and animal specimens to advance methods and techniques unique to nuclear reactors.

U.S. Geological Survey

https://www.usgs.gov/labs/nwql

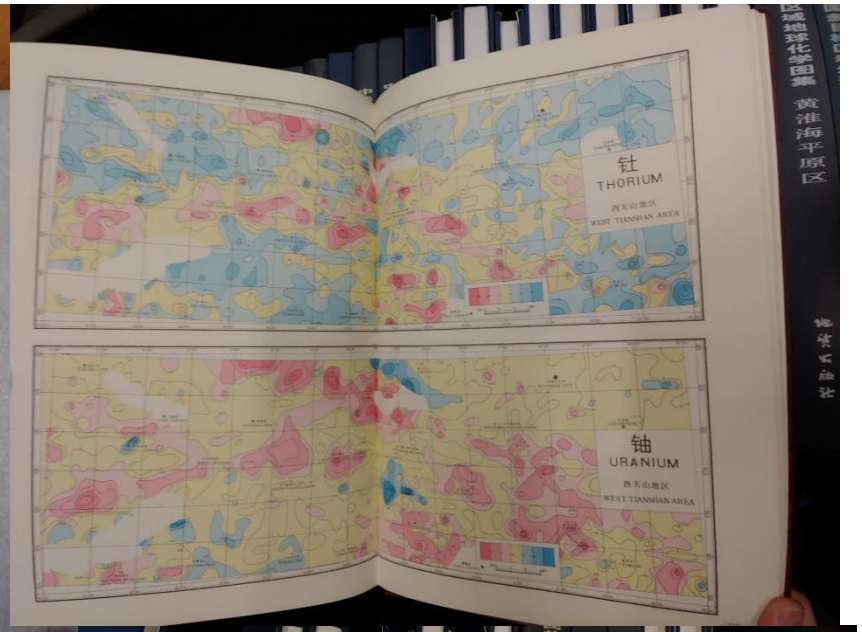


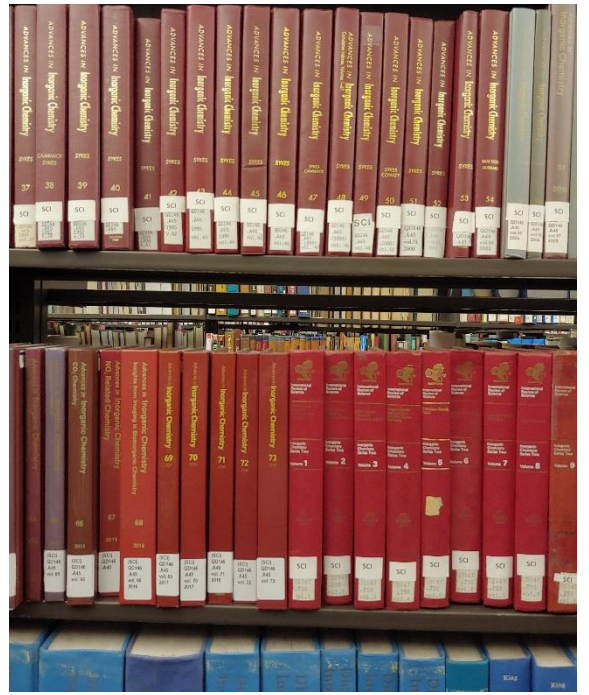
Methods used for the collection and analysis of chemical and biological data for the Tapwater Exposure Study, United States, 2016–17
https://pubs.er.usgs.gov/publication/ofr20181098

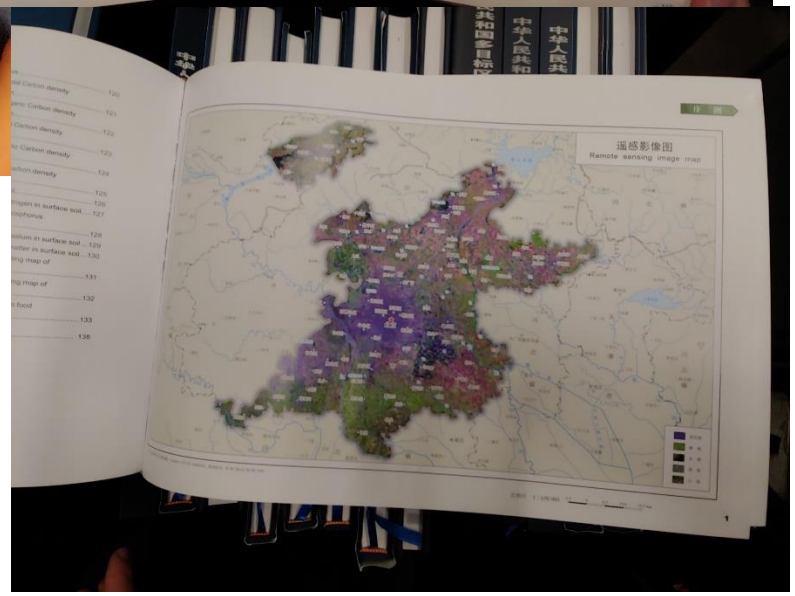
Prepared in cooperation with the Colorado School of Mines, Center for Environmental Risk Assessment; National Institutes of Health/National Institute of Environmental Health Sciences (NIH/NIEHS), National Toxicology Program Laboratory; University of Illinois at Chicago, School of Public Health; U.S. Environmental Protection Agency, National Exposure Research Laboratory; U.S. Environmental Protection Agency, National Health and Environmental Effects Laboratory

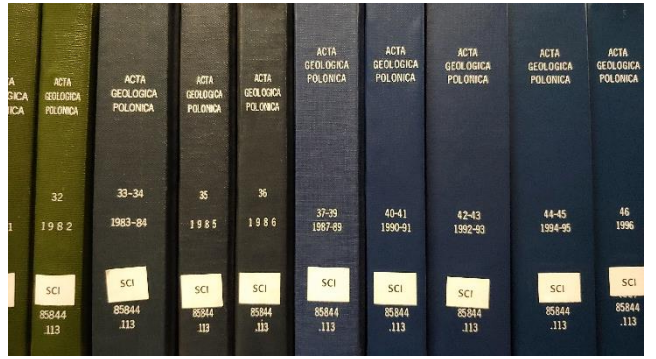
Princeton University Library

Geochemistry & Inorganic Chemistry









Recent Lewis Science Library & East Asian Library acquisitions: Geochemical Atlas series (China)
https://library.princeton.edu/find/all/Geochemical%20Atlas%20%20China

Acta geologica Polonica
Languages= Polish, English, French, Russian

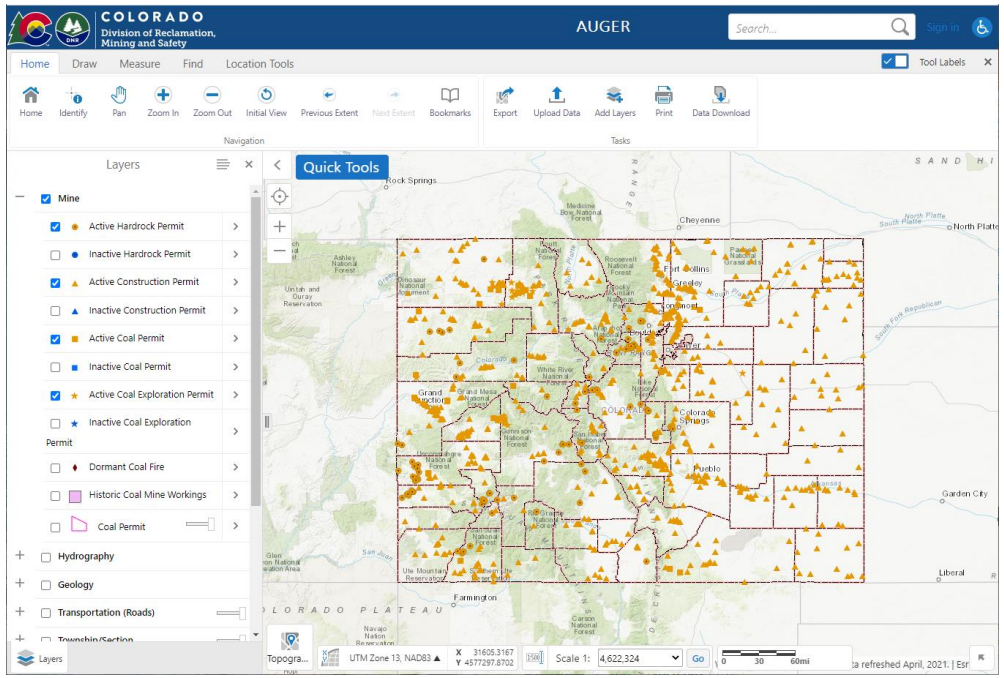
State Geological Surveys

https://www.stategeologists.org/

https://drms.colorado.gov/

https://drms.colorado.gov/data-search

https://maps.dnrgis.state.co.us/drms/Index.html?viewer=drms



Critical Minerals – Canada

https://www.nrcan.gc.ca/our-natural-resources/minerals-mining/critical-minerals/23414

Canada has a long history of producing many of these minerals, and has the potential to produce more.

- Aluminum
- Antimony
- Bismuth
- Cesium
- Chromium
- Cobalt
- Copper
- Fluorspar
- Gallium
- Germanium
- Graphite
- Helium
- Indium
- Lithium
- Magnesium
- Manganese
- Molybdenum
- Nickel
- Niobium
- Platinum group metals
- Potash
- Rare earth elements
- Scandium
- Tantalum
- Tellurium
- Tin
- Titanium
- Tungsten
- Uranium
- Vanadium
- Zinc

Français

Government of Canada | Gouvernement du Canada

Search the website

MENU

Canada.ca > Natural Resources Canada > Our Natural Resources > Minerals and mining

Critical minerals

Critical minerals are the building blocks for the clean and digitized economy. Learn about Canada's critical minerals list, actions and initiatives that help promote Canada's competitiveness, and resources related to critical minerals in Canada.

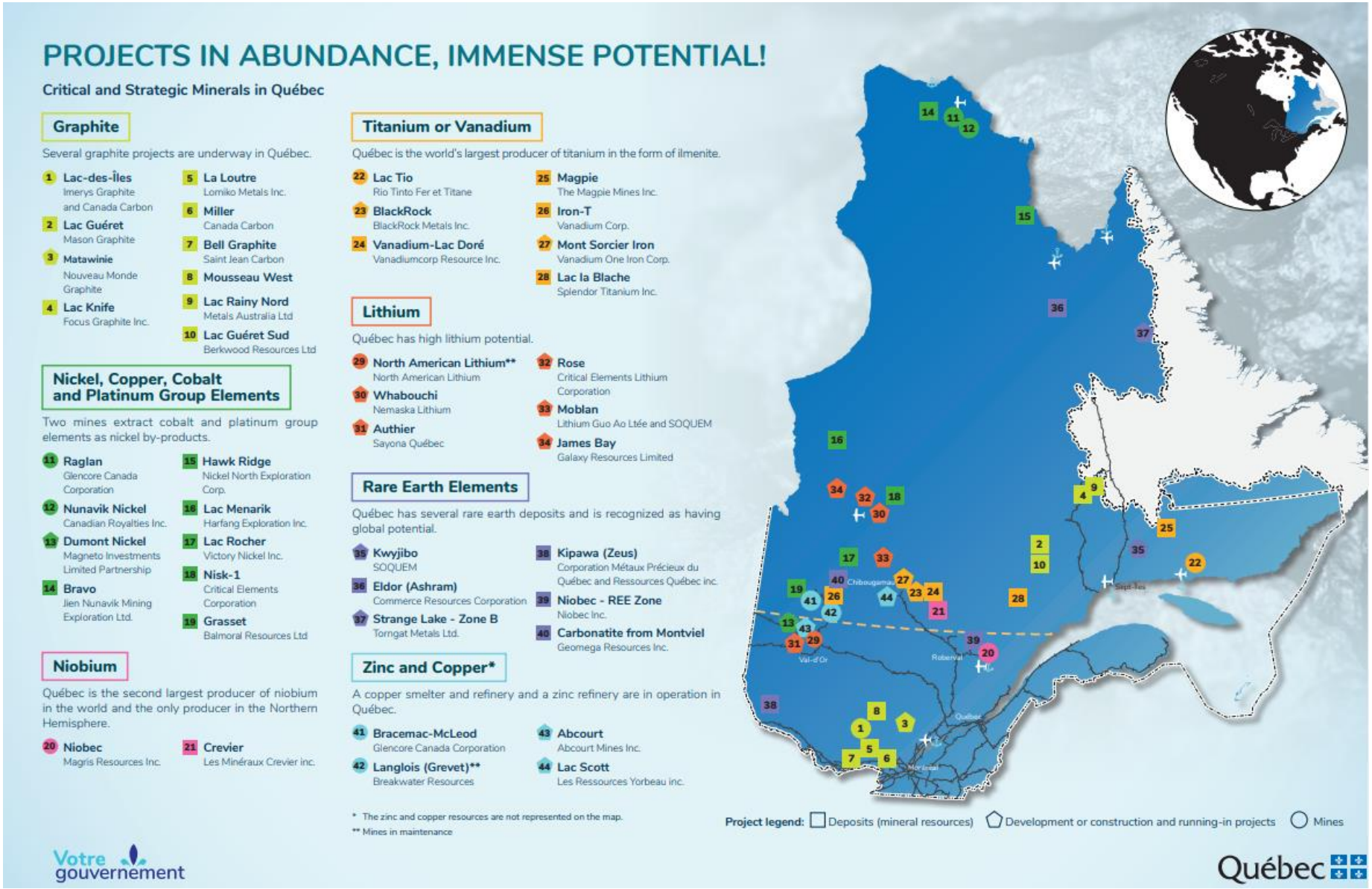
Critical minerals are vital to growing Canada's clean, modern economy

Canada is primed to capitalize on the rising global demand for critical minerals, driven in large part by their role in the transition to a low-carbon and digitized economy. Essential for renewable energy and clean technology applications (batteries, permanent magnets, solar panels and wind turbines), they are also required inputs for advanced manufacturing supply chains, including defence and security technologies, consumer electronics, agriculture, medical applications and critical infrastructure. Economies that quickly secure a position in shifting supply chains will be well situated for long-term economic growth and prosperity.

Critical Minerals – Quebec

Development of critical and strategic minerals in Québec

https://www.quebec.ca/en/agriculture-environment-and-natural-resources/mining/critical-and-strategic-minerals



May 31, 2021:
Critical and Strategic Minerals in Quebec - Quebec grants $ 3.35 million to support the production and upgrading of critical and strategic minerals
https://www.quebec.ca/nouvelles/actualites/details/les-mineraux-critiques-et-strategiques-au-quebec-quebec-accorde-335-m-au-soutien-de-la-production-et-de-la-revalorisation-de-mineraux-critiques-et-strategiques-31883

5N Plus is a leading global producer of specialty semiconductors and performance materials.
https://www.5nplus.com/#?lang=en

BERLIN, April 28 (Reuters) - With an eye on rapidly rising demand from Germany's electric vehicle industry, power and mining companies alike are striving to bring to the surface lithium trapped in underground springs of boiling hot water thousands of metres below the Rhine river.
https://www.reuters.com/business/sustainable-business/can-rhines-white-gold-power-germanys-green-e-car-race-2021-04-28/

Porsche To Build EV Battery Plant In Germany
Porsche's new German battery plant will also develop and build performance batteries.
https://www.torquenews.com/9900/porsche-build-ev-battery-plant-germany

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)

[Federal Institute for Geosciences and Natural Resources]

Mineral commodities

https://www.bgr.bund.de/EN/Themen/Min_rohstoffe/min_rohstoffe_node_en.html

Mining Conditions and Trading Networks in Artisanal Copper-Cobalt Supply Chains in the Democratic Republic of the Congo (2021) (PDF, 6 MB)

Commodity TopNews 64 (2020): COVID-19 Crisis threatens responsible mineral supply chains - a case study based on the DR Congo (PDF, 2 MB)

Commodity TopNews 61 (2019): Tin from Myanmar – A Scenario for Applying the European Union Regulation on Supply Chain Due Diligence (PDF, 3 MB)

French language geological surveys

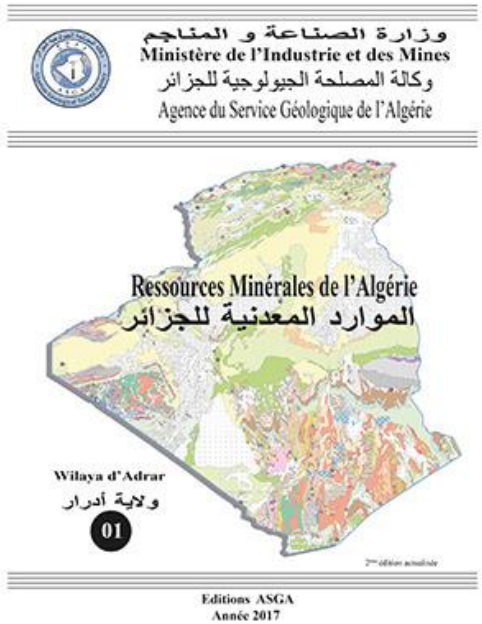
The Mineral Industry of Algeria:
https://www.usgs.gov/centers/nmic/africa-and-middle-east#ag

Algerian Geological Survey Agency
Ministère de l'Energie et des Mines Agence du Service Géologique de l'Algérie
https://asga.dz/

Livret Des Ressources Minérales https://asga.dz/livret-des-ressources-minerales/

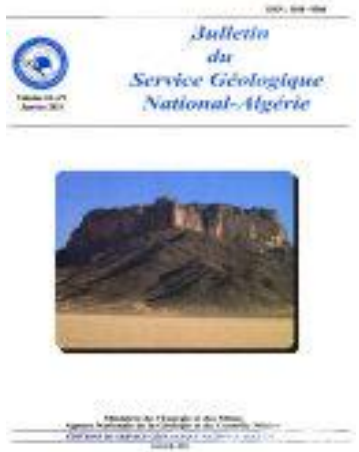
Bulletins Sommaires Échanges **https://asga.dz/bulletins-sommaires-echanges/**
https://asga.dz/wp-content/uploads/2021/04/Bulletin-Sommaire-1er-T-2021.pdf

Using mobile GIS applications to support mineral resource investigations in the Eglab region, Algeria
https://pubs.er.usgs.gov/publication/70206933



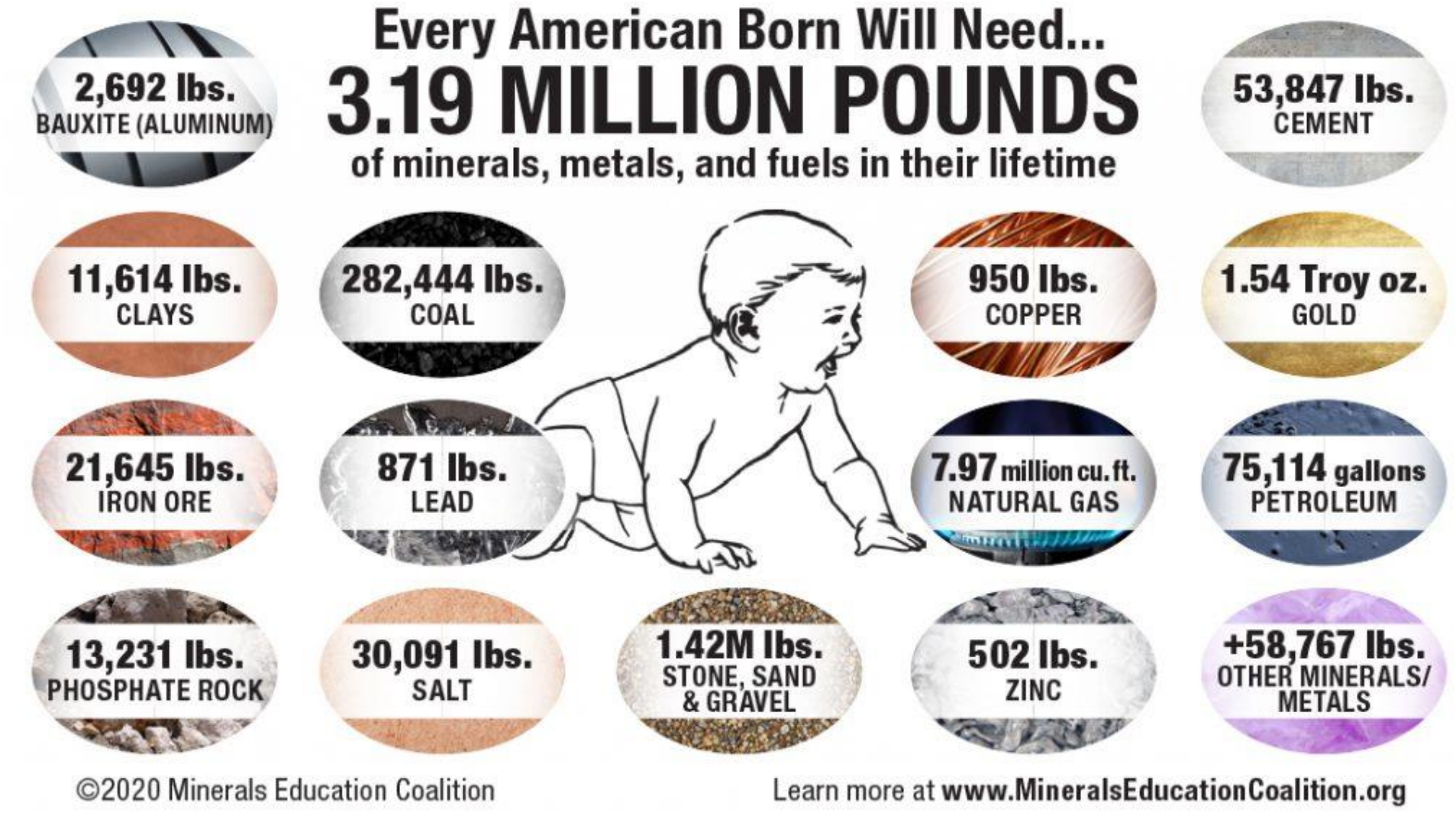
Bulletin du Service géologique national.
- Princeton University Library Catalog:
https://catalog.princeton.edu/catalog/5427215
- USGS Library Catalog: https://www.usgs.gov/core-science-systems/usgs-library/

He - Hélium: Algeria is #3 in world: 8.2 billion cubic meters
https://pubs.er.usgs.gov/publication/mcs2021



Mineral Baby

https://mineralseducationcoalition.org/



A Crosswalk of Mineral Commodity End Uses and North American Industry Classification System (NAICS) codes Open-File Report 2015-1163

https://pubs.er.usgs.gov/publication/ofr20151163

https://pubs.usgs.gov/of/2015/1163/ofr20151163_tables1-77.xlsx

Table 16. End uses of cobalt and corresponding North American Industry Classification System (NAICS) codes.

Table 16. End uses of cobalt and corresponding North American Industry Classification System (NAICS) codes.				
[Quantities given in metric tons. HSS, high speed steel]				
End use	NAICS	Quantity1	Percent1	
Chemical		17,080	28%	
Catalysts		5,490	9%	
Petrochemical	324			
Plastics	325			
Pigments		6,100	10%	
Glass, porcelain, ceramics	325			
Paints, ink	325			
Enamelware	325			
Tire adhesives, soaps, driers (paint/ink)		3,050	5%	
Steel braced radial tire	326			
Accelerators and catalysts (paint/ink)	325			
Feedstuffs, anodizing, recording media, electrolysis		2,440	4%	
Animal feed	311			
Cyanide poisoning antidote	325			
Cancer treatment	325			
Wear resistant coatings	325			
Magnetic recording devices	334			
Electrical/Electronic		20,740	34%	
Batteries		16,470	27%	
Portable devices	334			
Hybrid electric vehicles	335			
Electric vehicles	335			
Magnets		4,270	7%	
Generators	327, 332			
Hard magnets	327, 332			
Instrumentation	327, 332			
Motors	327, 332			
Rotating machines	327, 332			
Static transformers	327, 332			
Top performance electrical machines	327, 332			
Telephones	327, 332			
Machinery		7,930	13%	
Hard materials		7,930	13%	
Cemented carbides	325			
Machining metal				
Metal forming	333, 335			
Press tools	332, 333			

ofr20151163_tables1-77.xlsx

File Edit Insert Format Help

Times New ... 10

Glass

Table 37. End uses of lithium and correspondi

End use	NAICS
Chemical	
Greases/lubricants	324191
Rubber	326
Plastics	325, 326
Pharmaceuticals	325
Electrical/Electronic	
Lithium-ion batteries	335912
Manufacturing	
Ceramics	327910
Glass	327
Metallurgical	
Primary aluminum production	331312

ofr20151163_tables1-77.xlsx

File Edit Insert Format Help

Download Share

Arial 9

4Account for 32 percent of magnesium metal use.

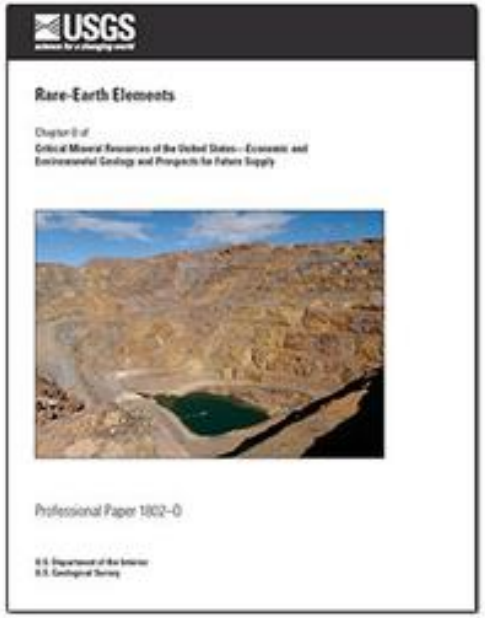
Table 38. End uses of magnesium and corresponding North American Industry Classification Syste

End use	NAICS	Percent
Magnesium Compounds		
Agricultural		13%
Animal feed	311	
Fertilizers	325	
Chemical		33%
Chemical intermediates1	325	
Road dust and ice control1	325	
Environmental		22%
Water treatment	325	
Stack-gas scrubbing	333	
Rubber1	326	
Pharmaceuticals1	335	
Construction/Building		
Cement	327	
Electrical	335	
Manufacturing		
Pulp and paper	322	
Metallurgical		53%
Refractories	327	
Magnesium Metals2		
Chemical		13%
Desulfurization of iron and steel	331	
Manufacturing		
Packaging3	333	
Castings4	331	
Wrought products4	331, 332	
Transportation3	336	
Other		14%

1Account for 11 percent of magnesium compound use.
2U.S. Geological Survey, 2010.
3Account for 41 percent of magnesium metal use.
4Account for 32 percent of magnesium metal use.

Rare Earths

https://www.usgs.gov/centers/nmic/rare-earths-statistics-and-information



Rare-Earth Elements
https://pubs.er.usgs.gov/publication/pp1802O

Table 02. List of selected rare-earth-element-bearing and yttrium-bearing ore minerals.

[Source: Jones and others (1996, Appendix A)]

Mineral name[1]	Chemical formula
Allanite	$(REE,Ca,Y)_2(Al,Fe^{3+})_3(SiO_4)_3(OH)$
Ancylite	$Sr(REE)(CO_3)_2(OH)\cdot H_2O$
Bastnaesite	$(REE)(CO_3)F$
Brannerite	$(U,Ca,Y,REE)(Ti,Fe)_2O_6$
Britholite	$(REE,Ca,Th)_5(SiO_4,PO_4)_3(OH,F)$
Burbankite	$(Na,Ca)_3(Sr,Ba,Ce)_3(CO_3)_5$
Cerianite-(Ce)	$(Ce^{4+},Th)O_2$
Eudialyte	$Na_4(Ca,REE)_2(Fe^{2+},Mn,Y)ZrSi_8O_{22}(OH,Cl)_2$
Fergusonite-(Y)	$YNbO_4$
Florencite	$(REE)Al_3(PO_4)_2(OH)_6$
Fluorapatite	$(Ca,REE,Na)_5(PO_4)_3(F,OH)$
Gadolinite	$(REE,Y)_2Fe^{2+}Be_2Si_2O_{10}$
Gorceixite	$(Ba,REE)Al_3(PO_4)_2(OH_5\cdot H_2O)$
Goyazite	$(Sr,REE)Al_3(PO_4)_2(OH_5\cdot H_2O)$
Iimoriite-(Y)	$Y_2SiO_4CO_3$
Kainosite	$Ca_2(Y,REE)_2Si_4O_{12}CO_3\cdot H_2O$
Loparite-(Ce)	$(Na,Ce,La,Ca,Sr)(Ti,Nb)O_3$
Monazite	$(REE,Th)PO_4$
Mosandrite	$(Ca,Na,REE)_{12}(Ti,Zr)_2Si_7O_{31}H_6F_4$
Parisite	$Ca(REE)_2(CO_3)_3F_2$
Rhapdophane	$(REE)PO_4\cdot H_2O$
Synchysite	$Ca(REE)(CO_3)_2F$
Thalenite-(Y)	$Y_3Si_3O_{10}OH$
Xenotime	YPO_4

[1]A more-extensive list that includes 245 individual rare-earth-element-bearing minerals is provided in Jones and others (1996, appendix A).

The principal economic sources of rare earths are the minerals bastnasite, monazite, and loparite and the lateritic ion-adsorption clays. The rare earths are a relatively abundant group of 17 elements composed of scandium, yttrium, and the lanthanides. The elements range in crustal abundance from cerium, the 25th most abundant element of the 78 common elements in the Earth's crust at 60 parts per million, to thulium and lutetium, the least abundant rare-earth elements at about 0.5 part per million. The elemental forms of rare earths are iron gray to silvery lustrous metals that are typically soft, malleable, and ductile and usually reactive, especially at elevated temperatures or when finely divided. The rare earths' unique properties are used in a wide variety of applications.

From PP-1802-O: "The rare-earth elements (REEs) are 15 elements that range in atomic number from 57 (lanthanum) to 71 (lutetium); they are commonly referred to as the "lanthanides." Yttrium (atomic number 39) is also commonly regarded as an REE because it shares chemical and physical similarities and has affinities with the lanthanides. Although REEs are not rare in terms of average crustal abundance, the concentrated deposits of REEs are limited in number."

Rare Earths

Rare-Earth Elements

https://pubs.er.usgs.gov/publication/pp1802O

Table 03. Active rare-earth mines, by deposit type.

[Mt, million metric tons; REE, rare-earth element; Y, yttrium; REO, rare-earth oxide; NA, not available; —; none reported]

Deposit	Location	Reported resource (Mt)	Reported grade (total REE+ Y oxide, in weight percent)	Comment	Reference(s)
			Carbonatites		
Bayan Obo	Nei Mongol Autonomous Region, China	800	6	Estimated resource in the total deposit, not subdivided	Berger and others (2009)
Daluxiang (Dalucao)	Sichuan, China	15.2	5.0	About 0.76 Mt (estimated) of REOs	Hou and others (2009)
Maoniuping	Sichuan, China	50.2	2.89	REO content of reserves is estimated to be more than 1.45 Mt	Xu and others (2008); Hou and others (2009); Xie and others (2009)
Weishan	Shandong, China	—	—	Tonnage and grade information are not available	NA
Mountain Pass	California, United States	16.7	7.98	Resource represents proven and probable reserves using a cutoff grade of 5 percent REO. Placed on care-and-maintenance status in 2015.	Molycorp, Inc. (2012)
Mount Weld	Western Australia, Australia	23.9	7.9	Tonnage represents the estimated combined total mineral resource as of January 2012 for two deposits at Mount Weld—the Central Lanthanide deposit and the Duncan deposit	Lynas Corporation Ltd. (2012)
			Peralkaline igneous		
Karnasurt Mountain, Lovozero deposit	Northern region, Russia	—	—	Loparite concentrate contains 30 to 35 percent REO	Zaitsev and Kogarko (2012)
			Heavy-mineral sand deposits		
Buena Norte mining district	East coast of Brazil	—	—	Historic and active producer of REEs from monazite in coastal sands	NA
			Ion-adsorption clay deposits		
Dong Pao Mine	Vietnam	—	—	Mine is reportedly in a late stage of development. Laterite clays overlie syenite intrusions	NA
South China clay deposits	Jiangxi, Hunan, Fujian, Guangdong, and Guangxi Provinces, southern China	—	About 0.05 to 0.4	Numerous small mines. Little ore information is available. Best source of data may be Chi and Tian (2008)	Clark and Zheng (1991); Bao and Zhao (2008); Chi and Tian (2008)

Library Classification Systems

U.S. Geological Survey Library Classification System

https://pubs.usgs.gov/bul/b2010/ &
https://usgs.primo.exlibrisgroup.com/discovery/search?vid=01USGSL_INST:01USGSL_INST

SECTION 5 -- MINERAL RESOURCES, MINERAL INDUSTRIES, AND ECONOMIC GEOLOGY
(Add geographic numbers for regions as needed)

401 Congresses
402 Mineral resources agencies and mining bureaus of countries, states, and provinces
(Includes map texts by bureaus of mines and mineral resources not classified elsewhere)
EXAMPLES:
402(100) Canada. Mineral Resources Division
402(274) Arizona Dept. of Mineral Resources
402(120) Nova Scotia Dept. of Mines
403 Mineral resources and mineral industries
(textbooks and general works)
403.1 Mineral technology
(Includes economic aspects of mineral technology)
404 Economic aspects of mineral resources and mineral industries including economic geology
405 Encyclopedias and catalogs (for mineral locations)
406 Nomenclature and classification
407 History
(Includes mining history)
408 General mineral and metal statistics
409 Essays, collections, and special topics
410 Ore deposits
(Includes metal deposits; metallogeny, origin and formation of ores; all other aspects of ore deposits including geochemical and thermodynamic aspects)
411 Lodes, veins, dikes
412 Rock-forming minerals
413 Trace elements (minor and accessory elements)
414 Placer deposits
415 Economic aspects of metal deposits
(Includes analyses for economic use)
416 Microscopic determination
420 Mines and mining
421 Mining law and legislation
422 Economic aspects of mines and mining
(Includes mine prospectuses and reports)
422.5 Mining company and corporate annual reports
424 Mine surveying
425 Mining methods and working
(Includes mining engineering, mine safety, strip mining, longwall mining, and rock bursts)
425.2 Mining subsidences
426 Prospecting
(Geophysical methods in general including water and well logging; for oil well logging, see see 467.4)
426.2 Geochemical prospecting
426.3 Seismic prospecting
426.4 Other specific prospecting methods
(Includes electric, nuclear (radioactive), gravity, magnetotelluric, torsion balance methods, and so forth)

(400) SOUTH AMERICA

(410) Brazil
(420) Argentina
(429) Patagonia
(430) Chile
(440) Bolivia
(450) Peru
(460) Colombia
(465) Ecuador
(470) Venezuela
(480) Guyana
(481) French Guiana
(482) Surinam
(formerly Netherlands Guiana or Dutch Guiana)
(490) Uruguay
(492) Paraguay
(497) Falkland Islands
(includes South Georgia and South Sandwich Islands)

(500) EUROPE

(510) Great Britain
(511) Islands of northern Great Britain
(includes Orkney Islands, Fair Island, Shetland (Zetland) Islands, Hebrides: Outer Hebrides: Lewis and Harris, North Uist, South Uist, Barra, St. Kilda, and Flannan Islands; Inner Hebrides: Skye, Mull, Islay Islands, and other lesser islands and islets)
(512) Scotland
(515) Ireland
(Eire)
(516) Northern Ireland
(520) England and Wales
(520.5) Colonial geological surveys
(521) Islands of the Irish Sea: Isle of Man and so forth; Islands of St. Georges Channel: Lundy Island, Isles of Scilly, and so forth; Channel Islands: Alderney, Guernsey, Jersey, and Sark
(530) Germany, German Federal Republic
(530.11) Lower Saxony
(Niedersachsen)
(530.111) Hamburg
(530.112) Bremen
(530.12) Bavaria (Bayern)
(530.13) Rhineland-Palatinate
(Rheinland-Pfalz)
(530.14) Baden-Wurttemberg
(530.15) North Rhine-Westphalia
(Nordrhein-Westfalen)
(530.16) Hessen
(530.17 Schleswig-Holstein
(530.18) Saarland

Abbreviations	051.2
Abrasive materials	447
Abu Dhabi	(675)
Abyssinia, *see* Ethiopia	(772)
Acid deposition	583
Acid rain	583
Acoustics	825
Actinide series	439.4
Actinium	439.4
Actinolite	446.1
Aden	(673)
Aden, Gulf of	(072)
Administration	065.1
Administrative management	065.1
Adriatic Sea	(059)
Aerial photography	753.5
Aerial surveying	753.5
Aerolites, *see* Meteorites	130
Aeromagnetism	296
Afars and Issas	(772.5)
Afghanistan	(655)
Africa	(700)
* Africa, French Equatorial	(758)
Africa, French West, *see* Central African Republic	(756)
Africa, North	(710)
Africa, West Central, *see* West and Central Africa	(750)
Agate	485
Age determination	315
Aggregate	479
Agricultural chemistry	892
Agricultural engineering	779
Agricultural water-supply	790
Agriculture	940
Agronomy (soil science)	941
Air pollution	514
Alabama	(235)
Alaska	(286)
Alaska, Gulf of	(083)
Albania	(596.6)
Alberta	(170)
Aleutian Islands	(286)
Algae	931
Algae (fossil)	697.1
Algebra	712
Algeria	(730)
Alkali earth metals	439.2
Alkali metals	439.21
Alloys	895
Alluvium	546
Almanacs	055
Alsace-Lorraine *(530.9)	(540.7)
Altitudes	752
Alum	444
Alum stone	444
Aluminum	438
Alunite	444
Amalthea	(030.5)
Amber	469
American coasts	(083)
American Samoa	(960)
Americium	439.4
Amethyst	489
Ammonites	659
Amosite	446.1
Amphibia	993
Amphibia (fossil)	673
Amphiboles	446.1
Amphineura	657
Amundsen Sea	(096)
Ananke	(030.6)
Analytical chemistry	880
Analytical geometry	715
Andhra Pradesh	(646)
Andorra	(565)
Angiosperms	937
Angiosperms (fossil)	698.4
Anglo-Egyptian Sudan, *see* Sudan	(720.5)
Angola	(768)
Anguilla	(396)
Animal ecology	919.97
Animals and plants, distribution of	918
Animals, distribution of	978
Annelida	984
Annelida (fossil)	645
Antarctic regions	(990)
Antarctic Sea	(096)
Antarctica	(990)
Anthophyllite	446.1
Anthozoa	982
Anthozoa (fossil)	625

Library Classification Systems

Library of Congress Library Classification System

Geology = Subclass QE

QE1-996.5 Geology
- QE1-350.62 General Including geographical divisions
- QE351-399.2 Mineralogy
- QE420-499 Petrology
- QE500-639.5 Dynamic and structural geology
- QE521-545 Volcanoes and earthquakes
- QE601-613.5 Structural geology
- QE640-699 Stratigraphy
- QE701-760 Paleontology
- QE760.8-899.2 Paleozoology
- QE901-996.5 Paleobotany

Red = Call Numbers I use for Mineral Research Inquiries at Princeton University:

Chemistry = Subclass QD

QD1-999 Chemistry
- QD1-65 General
- QD71-142 Analytical chemistry
- QD146-197 Inorganic chemistry
- QD241-441 Organic chemistry
- QD415-436 Biochemistry
- QD450-801 Physical and theoretical chemistry
- QD625-655 Radiation chemistry
- QD701-731 Photochemistry
- QD901-999 Crystallography

Mining = Subclass TN

TN1-997 Mining engineering. Metallurgy
- TN263-271 Mineral deposits. Metallic ore deposits. Prospecting
- TN275-325 Practical mining operations. Safety measures
- TN331-347 Mine transportation, haulage and hoisting. Mining machinery
- TN400-580 Ore deposits and mining of particular metals
- TN600-799 Metallurgy
- TN799.5-948 Nonmetallic minerals
- TN950-997 Building and ornamental stones

Time & Terrain

Database of the Geologic Map of North America: Adapted from the Map by J.C. Reed, Jr. and others (2005)
Data Series 424
Prepared in cooperation with the Geological Society of America
By: Christopher P. Garrity and David R. Soller

https://ngmdb.usgs.gov/gmna/

Generalized Geologic Map of the United States, Puerto Rico, and the U.S. Virgin Islands
https://pubs.usgs.gov/atlas/geologic/

Mineral Resources Online Spatial Data

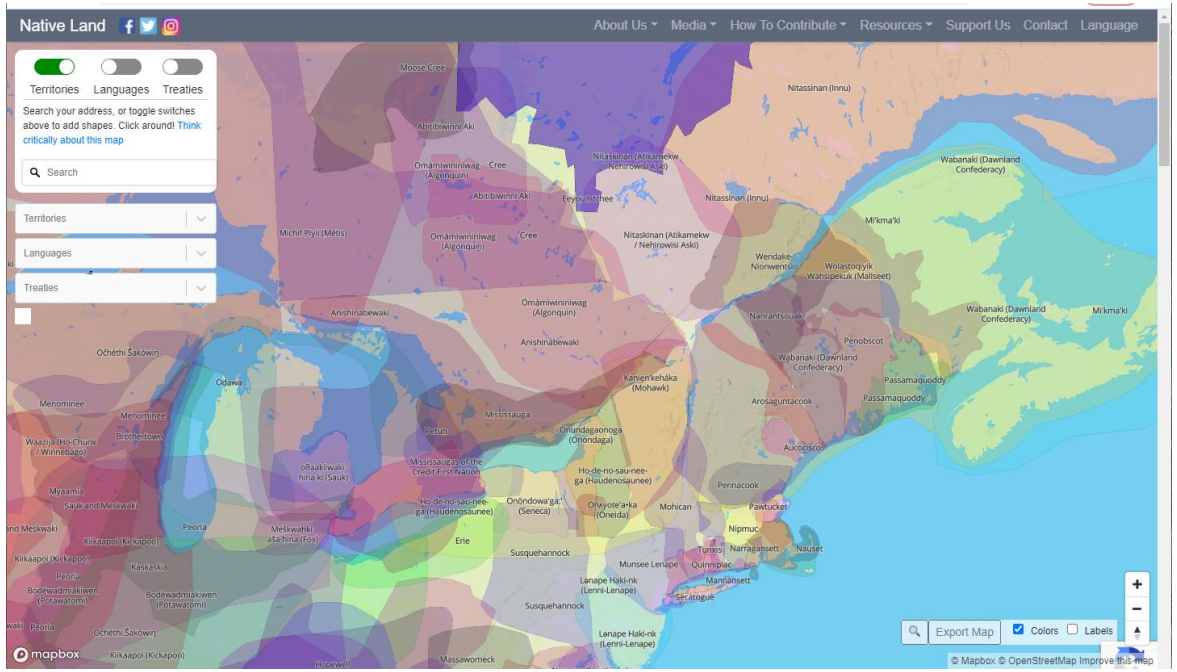
https://mrdata.usgs.gov/

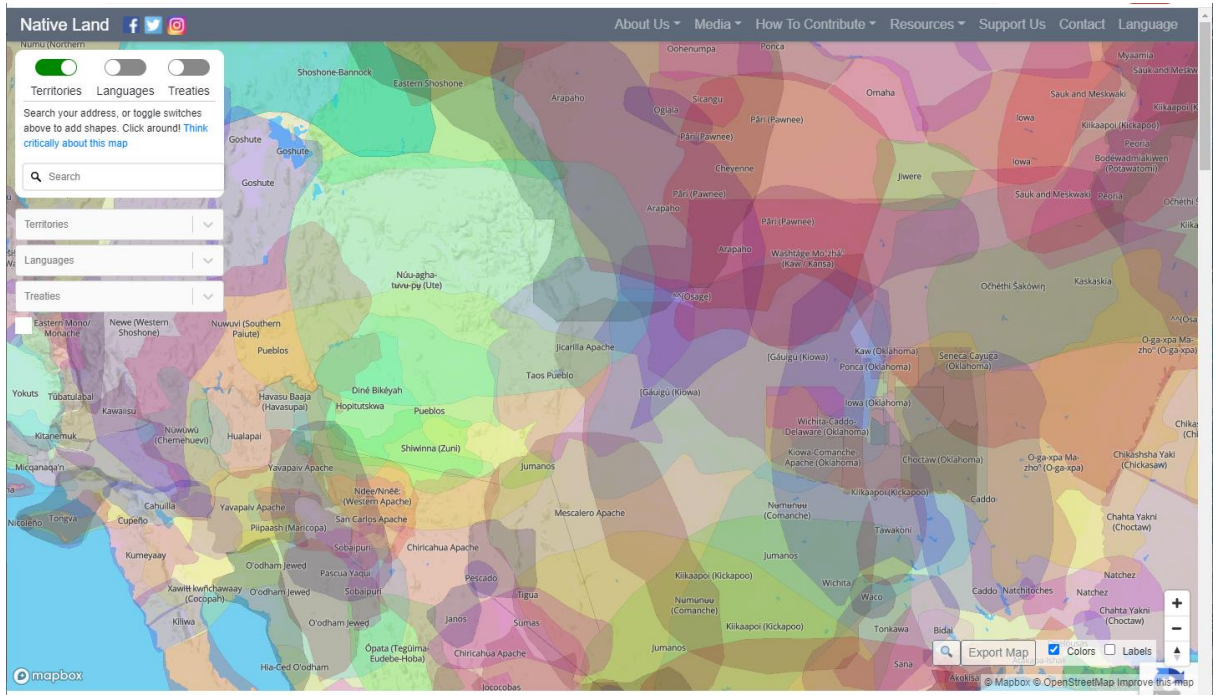
Earth MRI: https://www.usgs.gov/special-topic/earthmri

Examples:
MRDS: https://mrdata.usgs.gov/mrds/find-mrds-graded.php
Earth MRI, Critical Minerals – Focus Areas: https://mrdata.usgs.gov/earthmri/focus-areas/

https://native-land.ca/

Indigenous Communities





Saint Regis Mohawk https://www.srmt-nsn.gov/environment/remediation-restoration/superfund

Jan 13, 2021: Navajo Nation, New Mexico reach settlements over 2015 mine spill https://www.pbs.org/newshour/nation/navajo-nation-new-mexico-reach-settlements-over-2015-mine-spill

General Motors Superfund Site
https://www.srmt-nsn.gov/environment/remediation-restoration/superfund/general-motors-superfund-site

Reynolds Metals Superfund Site (Alcoa East)
https://www.srmt-nsn.gov/environment/remediation-restoration/superfund/reynolds-metals-superfund-site

My most Asked Question = Uranium and Navajo Nation

USGS Gold King Mine: https://www.usgs.gov/mission-areas/water-resources/science/gold-king-mine-release-2015-usgs-water-quality-data-and?qt-science_center_objects=0#qt-science_center_objects

Thank you! Questions?

Emily C. Wild

Princeton University Library

ewild@princeton.edu

Schedule a Research Consultation : Mon – Fri