

“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”

Past GPO Presentations

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

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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

Major Import Sources of Nonfuel Mineral Commodities for which the United States was greater than 50% Net Import Reliant in 2020



Source: U.S. Geological Survey

<https://pubs.er.usgs.gov/publication/mcs2021>

- **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

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>

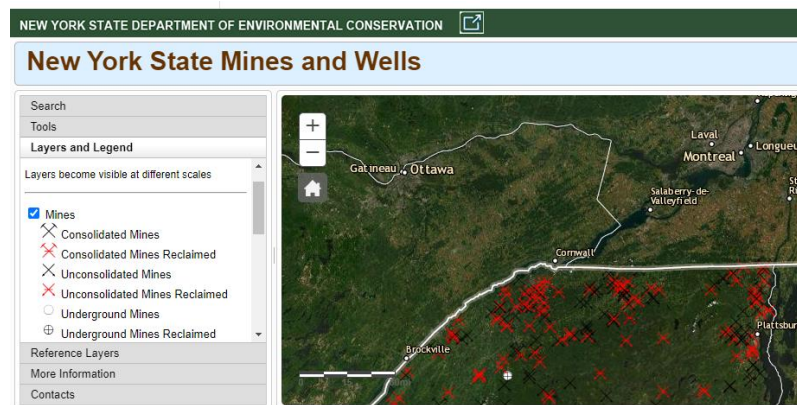
Princeton University Library, 2018-Present
Chemistry, Geosciences and Environmental Studies Librarian

U.S. Geological Survey: <https://www.usgs.gov/staff-profiles/emily-wild>

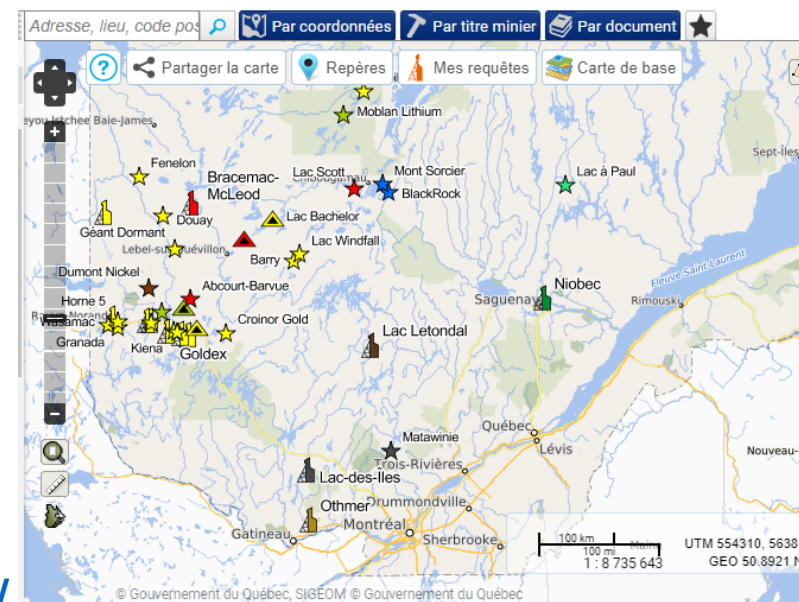
2008-2018 - Librarian (Physical Scientist): Denver, Colorado

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/11108_afchCarteIntr

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
Period 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			
Period 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			
Period 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
Period 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
Period 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)
Period 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 Ff (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

	Alkali metals		Lanthanides
	Alkaline earth metals		Actinides
	Transition metals		Nonmetals
	Post-transition metals		Halogens
	Metalloid		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/>

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)

Diodes
A diode is a two-terminal electronic component that conducts current primarily in one direction. It consists of a p-n junction.

Electronics and Circuitry
The circuit of copper is a widely used conductor. Copper conducts electricity well and is used in many electronic devices.

Metals
Metals are a primary source of energy. They are used in many applications, from construction to transportation.

Carbon
Carbon is a non-metallic element that is used in many applications, from pencils to diamonds.

Silicon
Silicon is a semiconductor that is used in many electronic devices, including computers and smartphones.

Aluminum
Aluminum is a metal that is used in many applications, from construction to transportation.

Iron
Iron is a metal that is used in many applications, from construction to transportation.

Steel
Steel is a metal alloy that is used in many applications, from construction to transportation.

Plastics
Plastics are synthetic materials that are used in many applications, from packaging to construction.

Composites
Composites are materials made from two or more different materials, used in many applications, from construction to transportation.

Advanced Materials
Advanced materials are materials with unique properties, used in many applications, from aerospace to medicine.

<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>

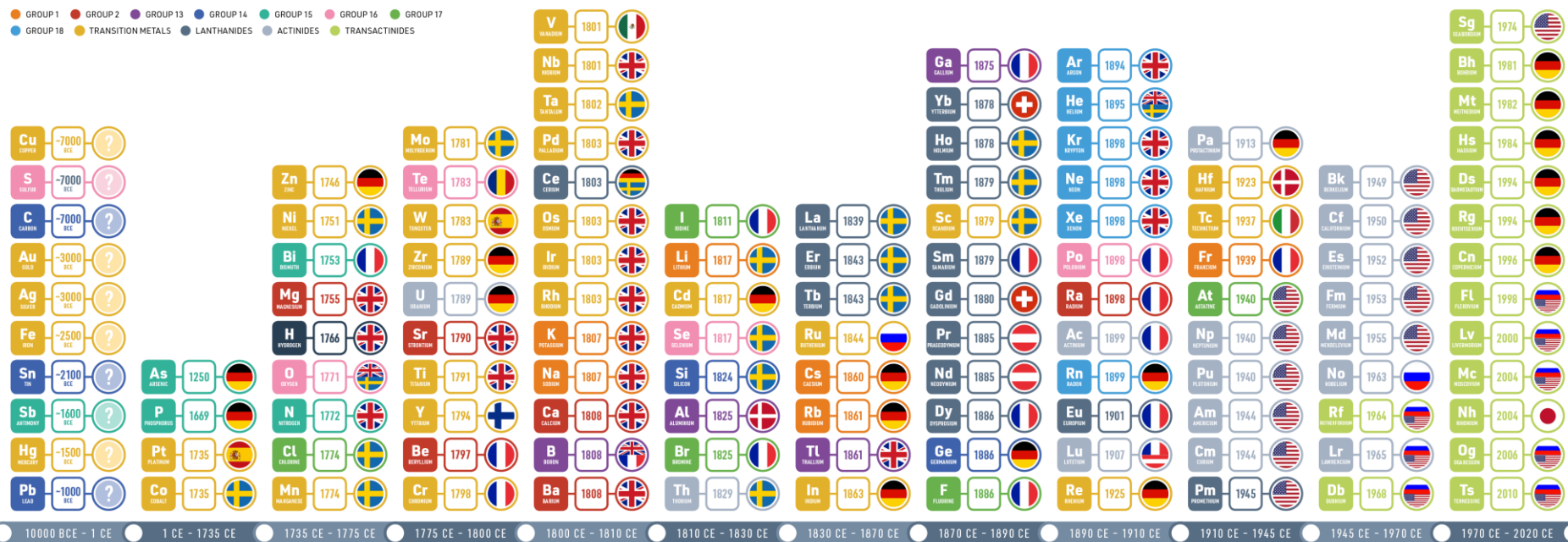


France: Société Chimique de France
<https://new.societechimiquedefrance.fr>



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

A TIMELINE OF THE DISCOVERIES OF THE CHEMICAL ELEMENTS



The years shown for element discoveries subsequent to those elements which were known since antiquity are those in which the element in question was isolated for the first time. The flags identify the country in which the discovery was made, rather than the nationality of the discoverer(s).



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

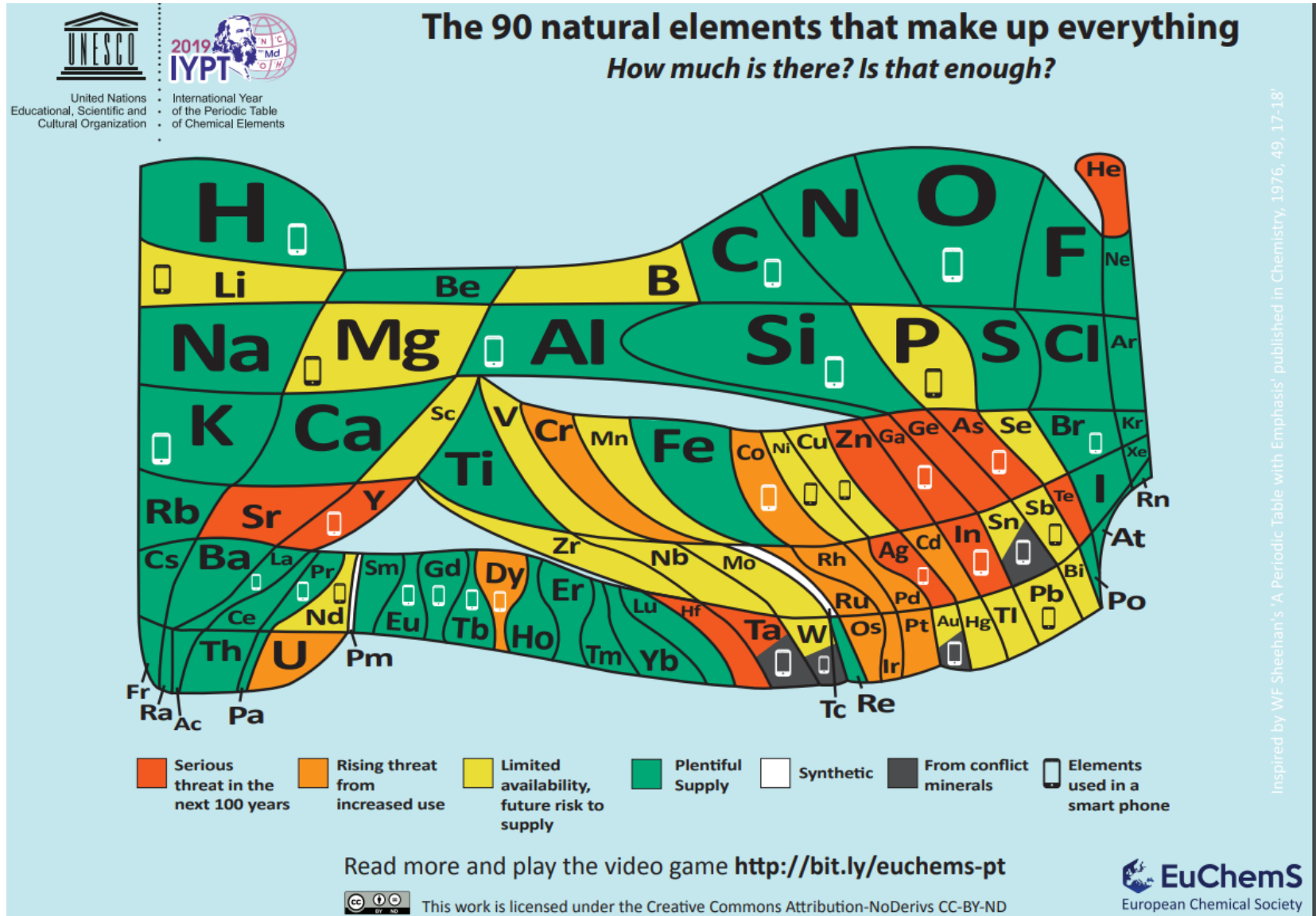
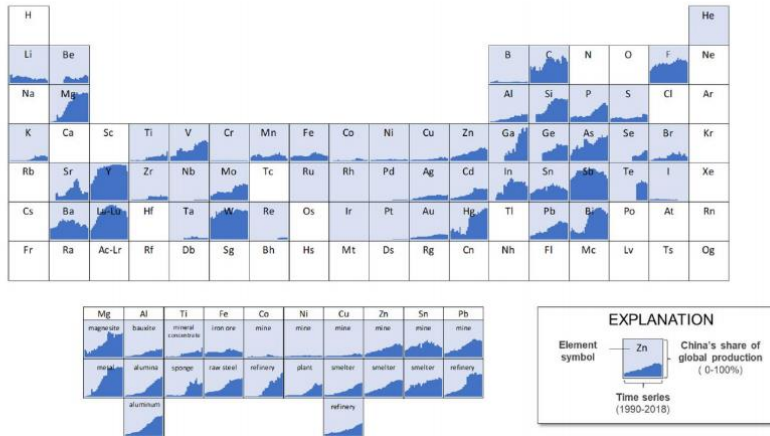


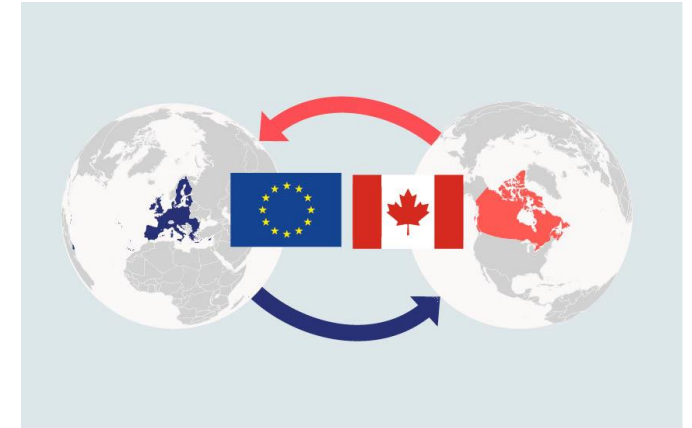
Figure 9: China's Share of Global Primary Production (1990-2018)³⁴



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

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



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

"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/>

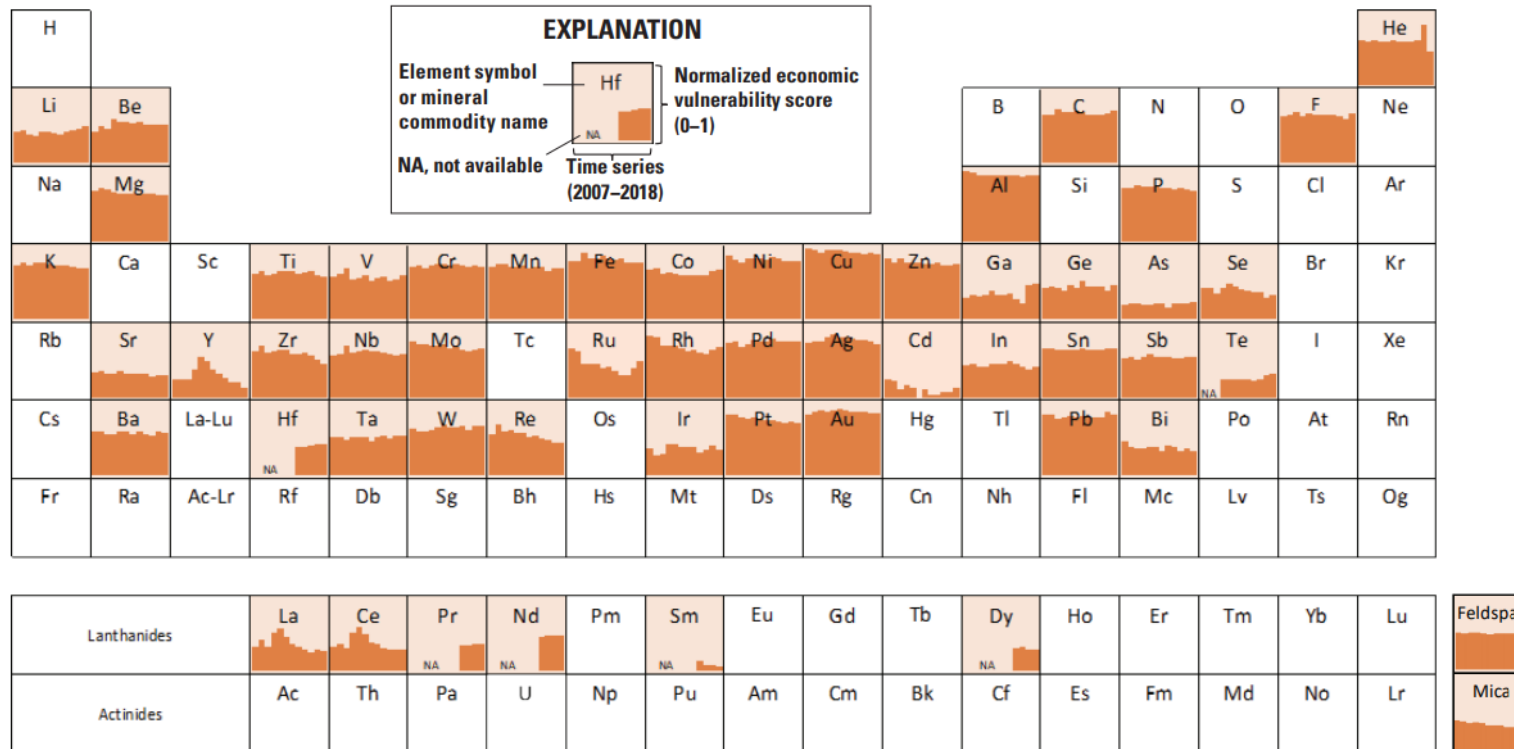
The leaders announced a new strategic partnership on raw materials to help ensure the security of supply chains for the critical minerals and metals that are essential to the transition to a cleaner and digitized economy, including for use in electric vehicles and advanced battery storage.

<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>

C. Economic vulnerability



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](#)

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.

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>

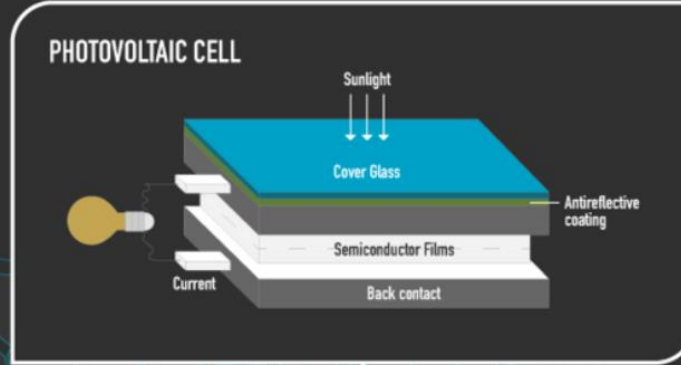
- [Aluminum \(bauxite\)](#), used in almost all sectors of the economy
- [Antimony](#), used in batteries and flame retardants
- [Arsenic](#), used in lumber preservatives, pesticides, and semi-conductors
- [Barite](#), used in cement and petroleum industries
- [Beryllium](#), used as an alloying agent 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>

Solar Panels

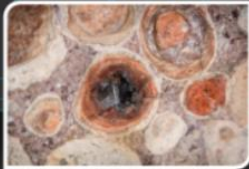
Several of the 35 mineral commodities listed as critical by the Department of the Interior play an important role in solar panels, where the Sun's energy is transformed to electricity.



ARSENIC

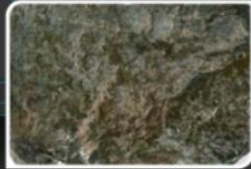
High-purity arsenic is used to produce gallium-arsenide and copper-indium-gallium-diselenide thin-film solar cells. In 2018, the United States was 100% reliant on foreign sources for arsenic.

Image Source: Getty IMAGES



GALLIUM

Used in gallium-arsenide and copper-indium-gallium-diselenide thin-film solar cells. In 2018, the United States was 100% reliant on foreign sources for gallium.



GERMANIUM

Germanium-based solar cells are commonly used in satellites. In 2018, the United States was more than 50% reliant on foreign sources for germanium.

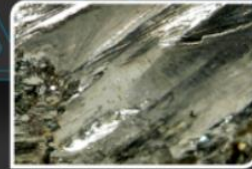
Image Source: Rob Lavinsky



INDIUM

Used in copper-indium-gallium-diselenide thin-film solar cells. In 2018, the United States was 100% reliant on foreign sources for indium.

Image Source: Nordstalker



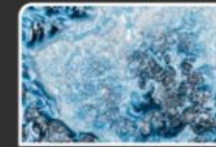
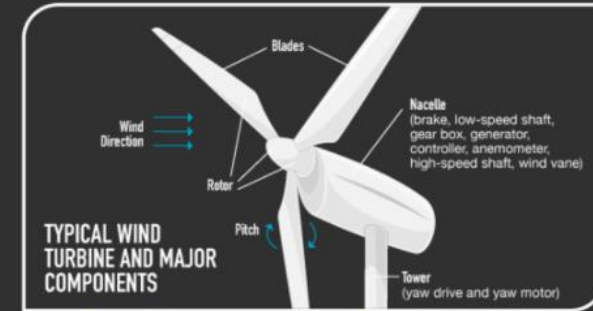
TELLURIUM

Used in cadmium-tellurium thin-film solar cells. In 2018, the United States relied on foreign sources for more than 75% of its tellurium.

Image Source: Rob Lavinsky

Wind Turbines

Wind turbines increasingly dot the American landscape, rising hundreds of feet in the air to capture electricity from the movement of the wind. Just like solar cells, wind turbines also rely on a few mineral commodities that have been designated as critical: aluminum and rare-earth elements.



ALUMINUM

Aluminum plays a role in most parts of a wind turbine, particularly in the nacelle, where the transfer of wind power to electricity occurs. The United States was 50% reliant on foreign sources for aluminum in 2018.



RARE-EARTH ELEMENTS

Responsible for some of the most powerful and efficient magnets on the planet, rare-earth elements enable wind turbines to have smaller, lighter generators. Although the United States mined and exported rare-earth minerals in 2018, it relied on imports to meet its domestic demands for rare-earth compounds, metals, and manufactured products.

Why do I help researchers with Critical Minerals?

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

Batteries

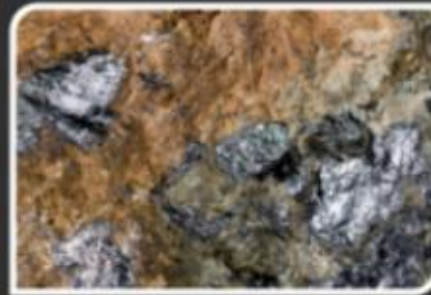
Batteries play an important supporting role for renewable energy sources like wind and solar, allowing excess power to be stored for usage when direct solar or wind power are unavailable. Just like the energy sources they complement, modern batteries rely on critical mineral commodities, particularly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



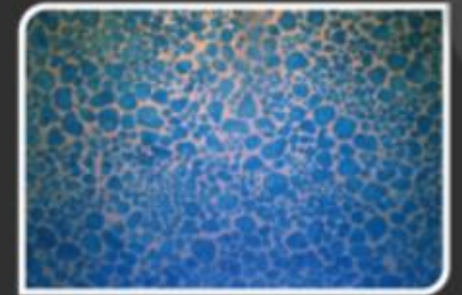
GRAPHITE

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.



A World of Minerals in Your Mobile Device

Mobile phones and other high-technology communications devices could not exist without mineral commodities. More than one-half of all components in a mobile device—including its electronics, display, battery, speakers, and more—are made from mined and semi-processed materials (mineral commodities). Some mineral commodities can be recovered as byproducts during the production and processing of other commodities. As an example, bauxite is mined for its aluminum content, but gallium is recovered during the aluminum production process. The images below show the **ore minerals** (sources) of some mineral commodities that are used to make components of a mobile device. On the reverse side, the map and table depict the major source countries producing some of these mineral commodities along with how these commodities are used in mobile devices. For more information on minerals, visit <http://minerals.usgs.gov>.

Display



A mobile device's glass screen is very durable because glassmakers combine its main ingredient, **silica** (silicon dioxide or quartz) **sand**, with ceramic materials and then add potassium.



Layers of indium-tin-oxide are used to create transparent circuits in the display. Tin is also the ingredient in circuit board solder, and **cassiterite** is a primary source of tin.



Gallium provides light emitting diode (LED) backlighting. **Bauxite** is the primary source of this commodity.



Sphalerite is the source of indium (used in the screen's conductive coating) and germanium (used in displays and LEDs).



Electronics and Circuitry

The content of copper in a mobile device far exceeds the amount of any other metal. Copper conducts electricity and heat and comes from the source mineral **chalcopyrite**.



Tetrahedrite is a primary source of silver. Silver-based inks on composite boards create electrical pathways through a device.



Silicon, very abundant in the Earth's crust, is produced from the source mineral quartz and is the basis of integrated circuits.



Arsenopyrite is a source of arsenic, which is used in radio frequency and power amplifiers.



Tantalum, from the source mineral **tantalite**, is added to capacitors to regulate voltage and improve the audio quality of a device.



Wolframite is a source of tungsten, which acts as a heat sink and provides the mass for mobile phone vibration.

Battery



Spodumene and subsurface brines are the sources of lithium used in cathodes of lithium-ion batteries.



Graphite is used for the anodes of lithium-ion batteries because of its electrical and thermal conductivity.



Speakers and Vibration

Bastnaesite is a source of rare-earth elements used to produce magnets in speakers, microphones, and vibration motors.



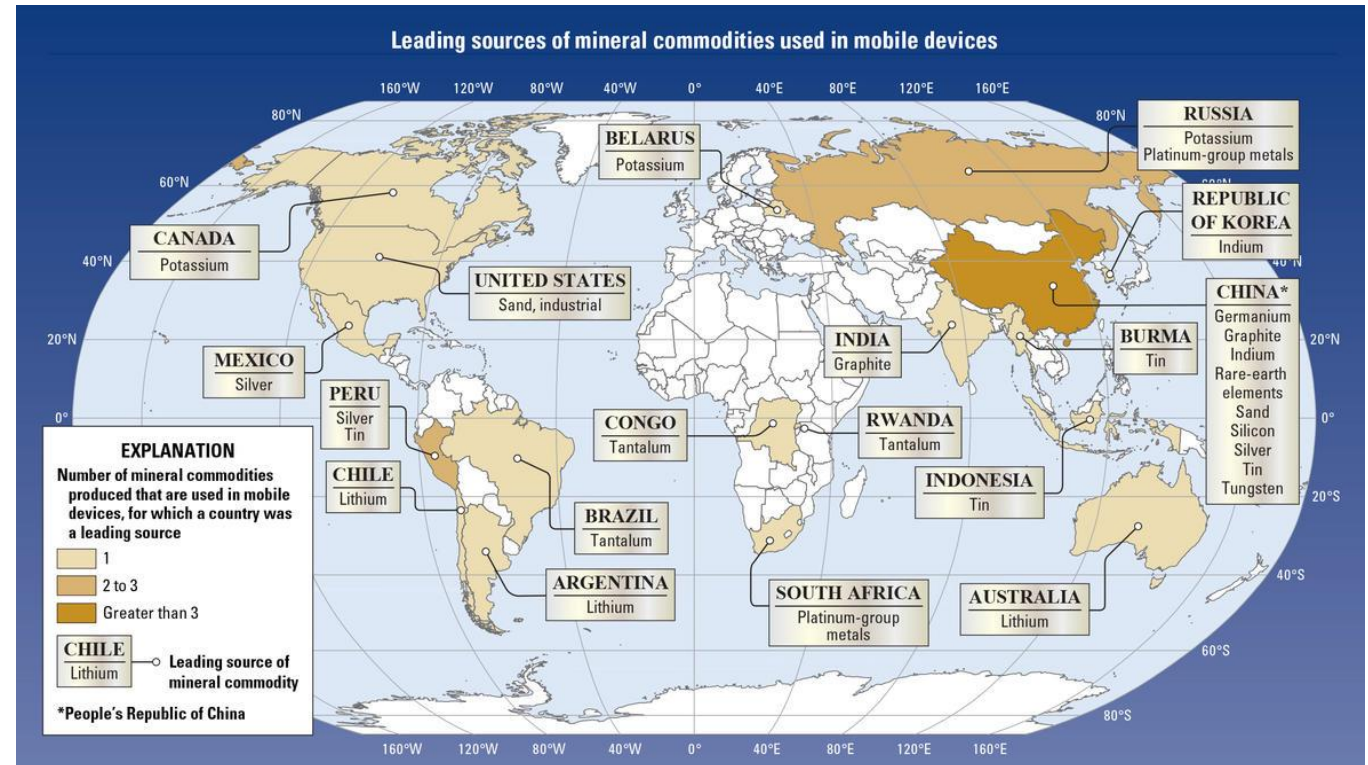
Source image courtesy of www.usgs.gov

U.S. Department of the Interior
U.S. Geological Survey

General Information Product 167
September 2016



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

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

- **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:

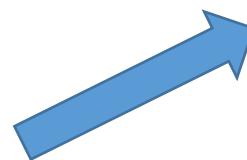
<https://pubs.er.usgs.gov/publication/pp1802L>

“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”



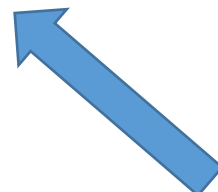
I help Chemists & Geologists prior to publication



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



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



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



<https://www.gsj.jp/en/gsj-link/directory/index.html>

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

The screenshot shows the website interface for the Geological Survey of Japan (GSJ). At the top, there is a navigation bar with links for 'Contact', 'Site Map', 'Location', and 'Japanese'. Below this is a search bar with 'ENHANCED BY Google' and a search icon, along with text size options (S, M, L). The main navigation menu includes 'GSJ HOME', 'About GSJ', 'Our Activities', 'Publications and Database', 'Geological Hazards', and 'Learning and Education'. The breadcrumb trail reads: 'GSJ HOME > Geological Survey of Japan, AIST > Collection of links > Geoscience Organizations of the World'. The page title is 'Geoscience Organizations of the World'. On the left, there is a sidebar menu with links: 'About GSJ', 'Our Activities', 'Purchase guide', 'Publications and Database', 'Geological Hazards', 'Learning and Education', 'GSJ Database Collection', and 'Collection of links'. Under 'Collection of links', there are sub-links for 'Earth Science Magazine' and 'Geoscience Organizations of the World'. The main content area features the title 'Directory of Geoscience Organizations of the World' and the text 'by Research Planning Office for Geological Survey of Japan, AIST'. Below the text is a satellite-style map of the world.





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

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>

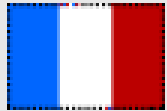
Saskatchewan Geological Survey <http://www.economy.gov.sk.ca/>

Yukon Geological Survey (YGS) <http://geology.gov.yk.ca/>

<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 Gullemin, 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/>



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/>

<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:

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<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](#)

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[Minerals Yearbook](#)

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| [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](#) |

<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

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•[Appendixes](#)

[Minerals Yearbook](#)

Lithium

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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		Reserves ⁵
	2019	2020 ⁶	
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	—	—	<u>2,100,000</u>
World total (rounded)	⁸ 86,000	⁸ 82,000	21,000,000

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

[Lithium--For Harnessing Renewable Energy](#)

Fact Sheet 2014-3035

[Lithium use in batteries](#)

Circular 1371

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

<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		Reserves ⁸
	2019	2020 ^e	
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.

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>

***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](#)

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

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>

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/reportingguidelines.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>



The Reston Stable Isotope Laboratory (RSIL) of the U.S. Geological Survey provides isotopic reference materials and calibrates user-supplied materials. Reference materials are suitable for use in calibration of analytical instrumentation, for testing analytical methodologies, and for use as quality control samples.

Colorado Laboratories:

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

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



Spectroscopy Lab

HOME

SCIENCE

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Spectrometers

Spectral Library

Hyperspectral Imaging

Laboratory Spectroscopy

Capabilities Topics

DATA AND TOOLS

MAPS

PUBLICATIONS

SOFTWARE

MULTIMEDIA

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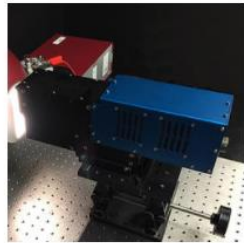
PARTNERS

DOCUMENTS

ABOUT

Capabilities

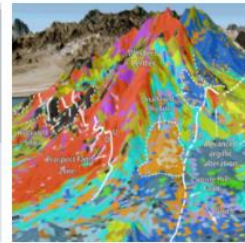
Themes



Spectrometers



Spectral Library



Hyperspectral Imaging



Laboratory Spectroscopy

Science Topics

Airborne Imaging Spectroscopy

Airborne Surveys

Core Scanning

Field Portable Imaging Spectrometer

Fourier Transform Infrared (FTIR)

Hand-Held Field Units

Laboratory Imaging Spectrometer

Mineral Mixtures

Minerals

Planetary Spectroscopy

Sample Measurements

Shortwave Infrared (SWIR)

Software Development

Spectrometer Calibration

Standard Operating Procedures (SOPs)

Techniques

Ultraviolet / Visible (UV/Vis)

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 rock materials. <https://www.usgs.gov/centers/gecsc/labs/mineralogy-and-microscopy-laboratory>

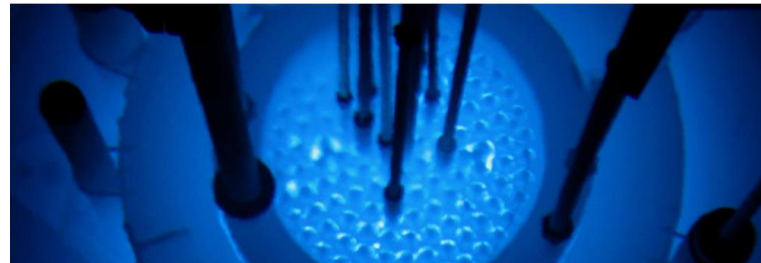
USGS TRIGA Reactor

<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 science by providing information on geologic, plant, and animal specimens to advance methods and techniques unique to nuclear reactors.



USGS TRIGA Reactor



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science for a changing world

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National Water Quality Laboratory

Methods, Research and Development

Formed in 1987 to address national-level concerns about toxic contaminants in the nation's water resources.

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RESEARCH

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Our National Water Quality Laboratory (NWQL) priority is to continue the important work of the Department of the Interior and the USGS, while also maintaining the health and safety of our employees and community. Based on guidance from the White House, the CDC, and state and local authorities, we are shifting our operations to a virtual mode and have minimal staffing within our offices.

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Related Links

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About WMA

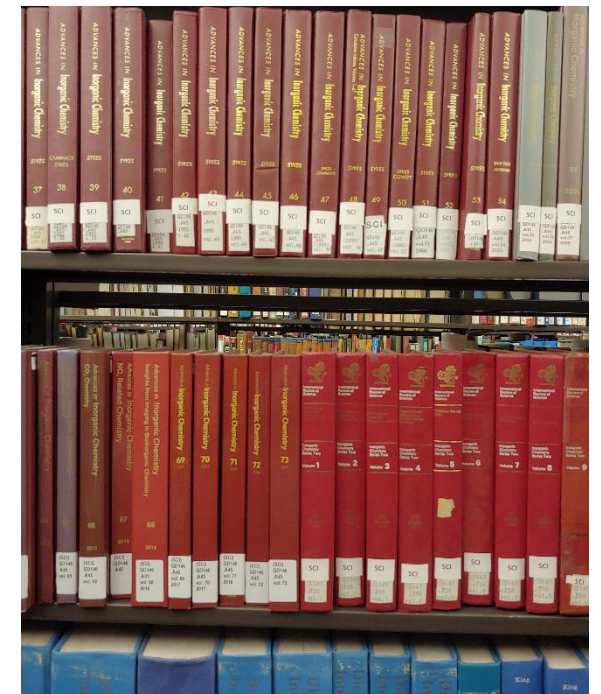
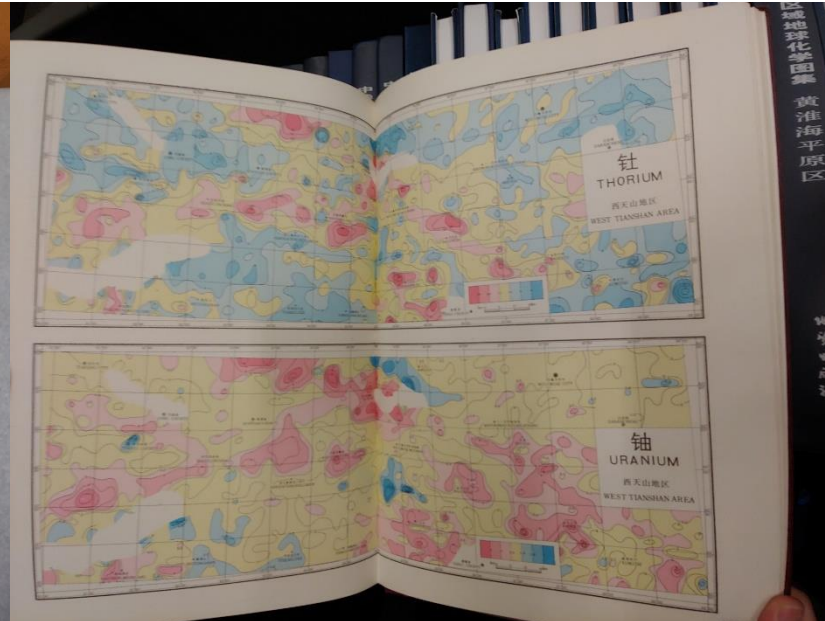
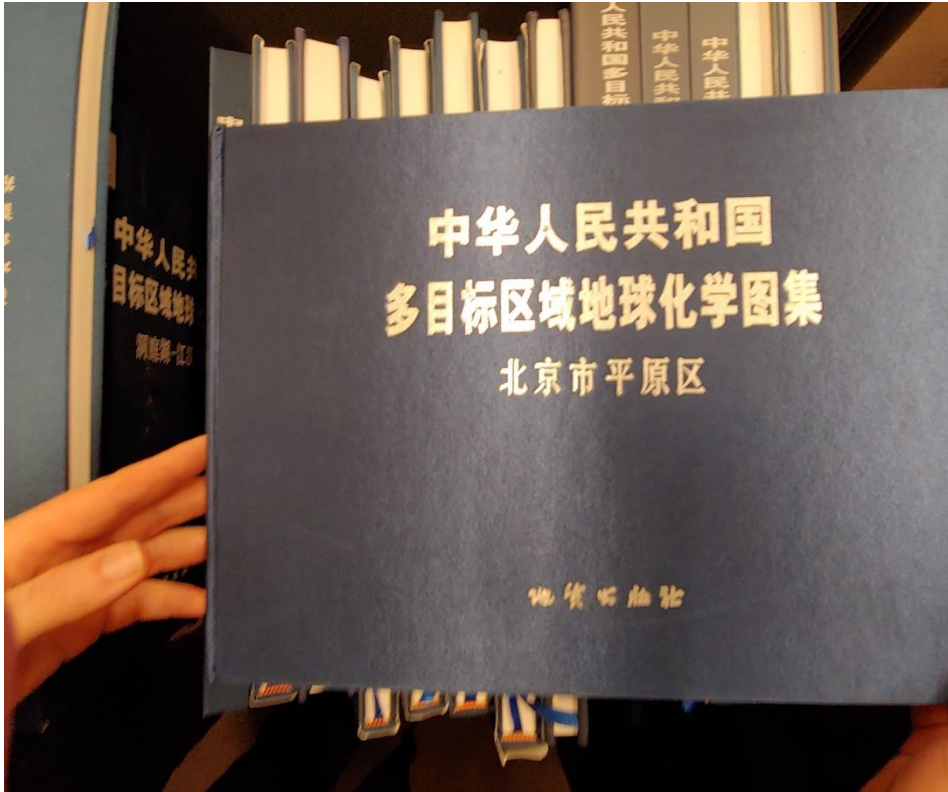
Science Topics

Students & Teachers

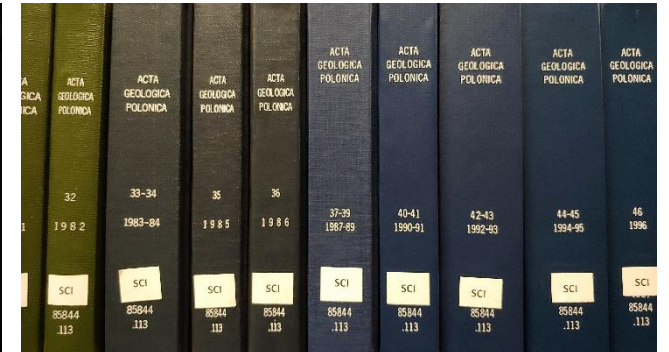
Methods used for the collection and analysis of chemical and biological data for the Tapwater Exposure Study, United States, 2016–17

<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



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



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

State Geological Surveys

<https://www.stategeologists.org/>



ABOUT ▾ AWARDS ▾ COMMITTEES FACT SHEETS IN REMEMBRANCE JOBS MEETINGS

The **Association of American State Geologists (AASG)** represents the State Geologists of the 50 United States and Puerto Rico. Founded in 1908, AASG seeks to advance the science and practical application of geology and related earth sciences in the United States and its territories, commonwealths, and possessions.

In the context of the present national and international outcry over continuing unjust treatment toward people of color in this country, the Association of American State Geologists, during our annual meeting held the week of June 8th, 2020, took steps to ensure that we will more actively face injustices and commit to challenging and changing the biases that lead to discriminatory practices against people of color.

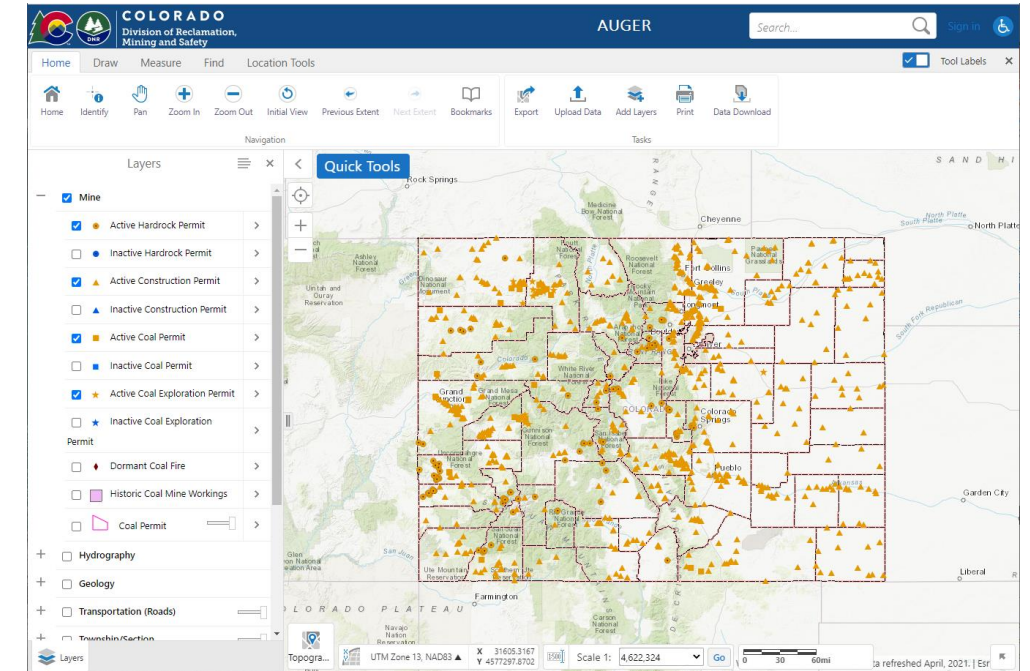
Click on a state below to go to its geological survey's website, or view the full list of state geological surveys.



<https://drms.colorado.gov/>

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

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



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

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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.

PROJECTS IN ABUNDANCE, IMMENSE POTENTIAL!

Critical and Strategic Minerals in Québec

Graphite

Several graphite projects are underway in Québec.

- | | |
|---|---|
| 1 Lac-des-Îles
Imerys Graphite and Canada Carbon | 5 La Loutre
Lomiko Metals Inc. |
| 2 Lac Guéret
Mason Graphite | 6 Miller
Canada Carbon |
| 3 Matawinie
Nouveau Monde Graphite | 7 Bell Graphite
Saint Jean Carbon |
| 4 Lac Knife
Focus Graphite Inc. | 8 Mousseau West |
| | 9 Lac Rainy Nord
Metals Australia Ltd |
| | 10 Lac Guéret Sud
Berkwood Resources Ltd |

Nickel, Copper, Cobalt and Platinum Group Elements

Two mines extract cobalt and platinum group elements as nickel by-products.

- | | |
|---|---|
| 13 Raglan
Glencore Canada Corporation | 15 Hawk Ridge
Nickel North Exploration Corp. |
| 12 Nunavik Nickel
Canadian Royalties Inc. | 16 Lac Menarik
Harfang Exploration Inc. |
| 13 Dumont Nickel
Magneto Investments Limited Partnership | 17 Lac Rocher
Victory Nickel Inc. |
| 14 Bravo
Jien Nunavik Mining Exploration Ltd. | 18 Nisk-1
Critical Elements Corporation |
| | 19 Grasset
Balmoral Resources Ltd |

Niobium

Québec is the second largest producer of niobium in the world and the only producer in the Northern Hemisphere.

- | | |
|--|---|
| 20 Niobec
Magris Resources Inc. | 21 Crevier
Les Minéraux Crevier Inc. |
|--|---|

Titanium or Vanadium

Québec is the world's largest producer of titanium in the form of ilmenite.

- | | |
|--|---|
| 22 Lac Tio
Rio Tinto Fer et Titane | 25 Magpie
The Magpie Mines Inc. |
| 23 BlackRock
BlackRock Metals Inc. | 26 Iron-T
Vanadium Corp. |
| 24 Vanadium-Lac Doré
Vanadiumcorp Resource Inc. | 27 Mont Sorcier Iron
Vanadium One Iron Corp. |
| | 28 Lac la Blanche
Splendor Titanium Inc. |

Lithium

Québec has high lithium potential.

- | | |
|---|--|
| 29 North American Lithium**
North American Lithium | 32 Rose
Critical Elements Lithium Corporation |
| 30 Whabouchi
Nemaska Lithium | 33 Moblan
Lithium Guo Ao Ltee and SOQUEM |
| 31 Authier
Sayona Québec | 34 James Bay
Galaxy Resources Limited |

Rare Earth Elements

Québec has several rare earth deposits and is recognized as having global potential.

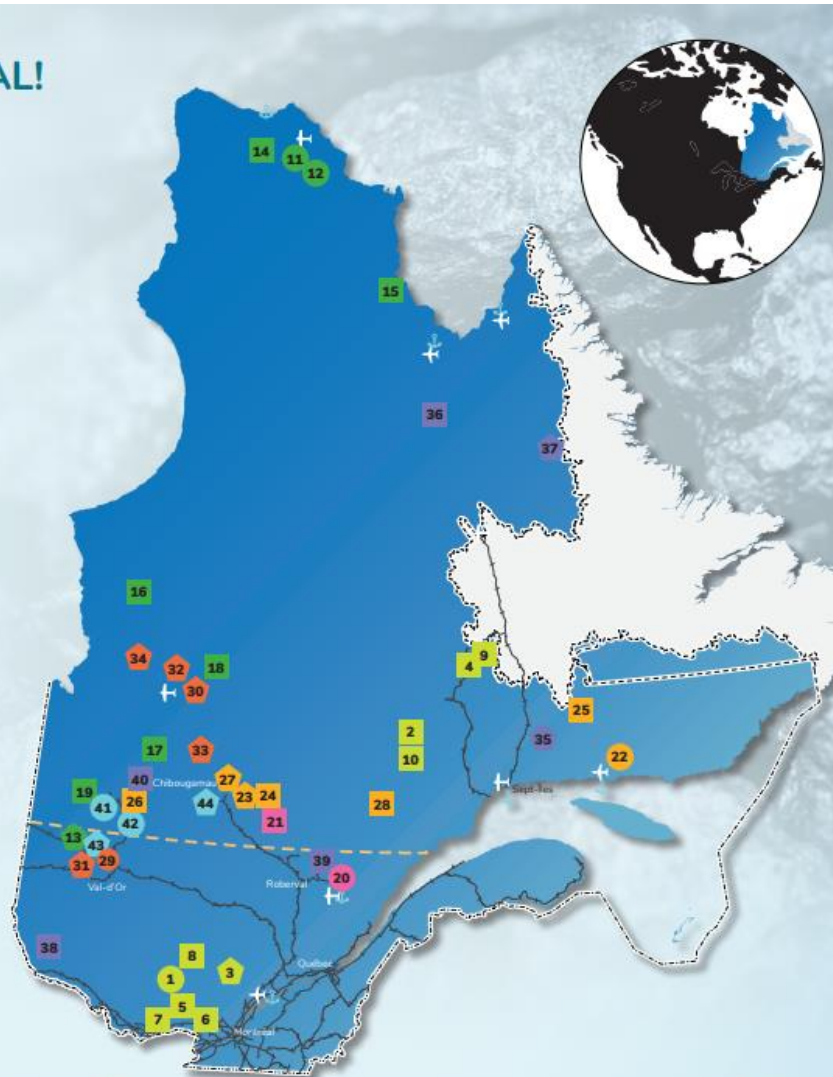
- | | |
|---|--|
| 35 Kwyjibo
SOQUEM | 38 Kipawa (Zeus)
Corporation Métaux Précieux du Québec and Ressources Québec Inc. |
| 36 Eldor (Ashram)
Commerce Resources Corporation | 39 Niobec - REE Zone
Niobec Inc. |
| 37 Strange Lake - Zone B
Tornat Metals Ltd. | 40 Carbonatite from Montviel
Geomega Resources Inc. |

Zinc and Copper*

A copper smelter and refinery and a zinc refinery are in operation in Québec.

- | | |
|---|---|
| 41 Bracemac-McLeod
Glencore Canada Corporation | 43 Abcourt
Abcourt Mines Inc. |
| 42 Langlois (Grevet)**
Breakwater Resources | 44 Lac Scott
Les Ressources Yorbeau inc. |

* The zinc and copper resources are not represented on the map.
** Mines in maintenance



Project legend: □ Deposits (mineral resources) ◊ Development or construction and running-in projects ○ Mines

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'Énergie et des Mines Agence du Service Géologique de l'Algérie

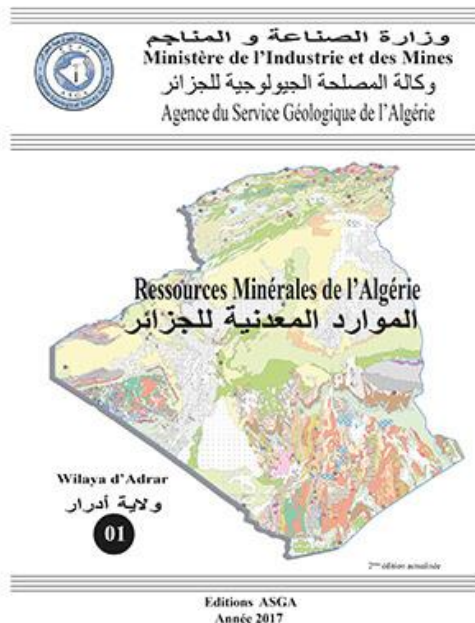
<https://asga.dz/>

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.

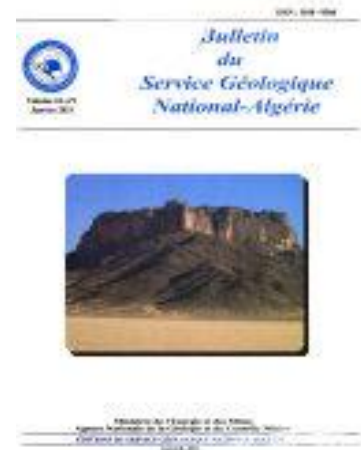
- Princeton University Library Catalog:

<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>



2,692 lbs.
BAUXITE (ALUMINUM)

11,614 lbs.
CLAYS

21,645 lbs.
IRON ORE

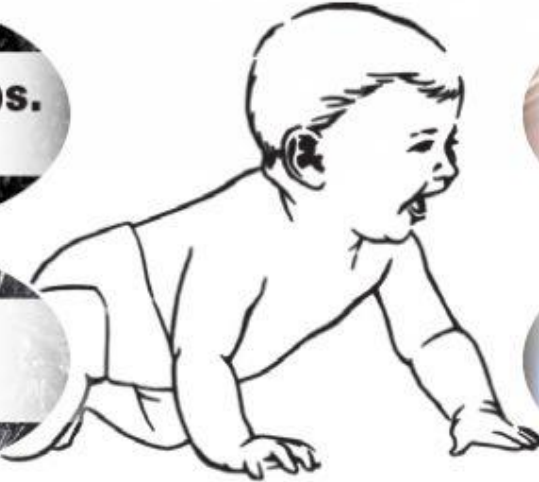
13,231 lbs.
PHOSPHATE ROCK

Every American Born Will Need...
3.19 MILLION POUNDS
of minerals, metals, and fuels in their lifetime

282,444 lbs.
COAL

871 lbs.
LEAD

30,091 lbs.
SALT



1.42M lbs.
STONE, SAND
& GRAVEL

950 lbs.
COPPER

7.97 million cu. ft.
NATURAL GAS

502 lbs.
ZINC

53,847 lbs.
CEMENT

1.54 Troy oz.
GOLD

75,114 gallons
PETROLEUM

+58,767 lbs.
OTHER MINERALS/
METALS

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.

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

Table 37. End uses of lithium and corresponding NAICS codes.

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

Table 38. End uses of magnesium and corresponding North American Industry Classification System (NAICS) codes.

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.

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 ₂) ₃ (OH)
Ancylite	Sr(REE)(CO ₃) ₂ (OH)•H ₂ O
Bastnaesite	(REE)(CO ₃)F
Brannerite	(U,Ca,Y,REE)(Ti,Fe) ₂ O ₆
Britholite	(REE,Ca,Th) ₄ (SiO ₄ PO ₄) ₃ (OH,F)
Burbankite	(Na,Ca) ₃ (Sr,Ba,Ce) ₃ (CO ₃) ₅
Cerianite-(Ce)	(Ce ⁴⁺ ,Th) ₂ O ₂
Eudialyte	Na ₄ (Ca,REE) ₂ (Fe ²⁺ ,Mn,Y)ZrSi ₅ O ₂₂ (OH,Cl) ₂
Fergusonite-(Y)	YNbO ₄
Florensite	(REE)Al ₃ (PO ₄) ₂ (OH) ₆
Fluorapatite	(Ca,REE,Na) ₅ (PO ₄) ₃ (F,OH)
Gadolinite	(REE,Y) ₂ Fe ²⁺ Be ₂ Si ₂ O ₁₀
Gorceixite	(Ba,REE)Al ₃ (PO ₄) ₂ (OH ₃ •H ₂ O)
Goyazite	(Sr,REE)Al ₃ (PO ₄) ₂ (OH ₃ •H ₂ O)
limoriite-(Y)	Y ₂ SiO ₄ CO ₃
Kainosite	Ca ₂ (Y,REE) ₂ Si ₄ O ₁₂ CO ₃ •H ₂ O
Loparite-(Ce)	(Na,Ce,La,Ca,Sr)(Ti,Nb)O ₃
Monazite	(REE,Th)PO ₄
Mosandrite	(Ca,Na,REE) ₁₂ (Ti,Zr) ₂ Si ₇ O ₃₁ H ₆ F ₄
Parisite	Ca(REE) ₂ (CO ₃) ₂ F ₂
Rhaphdophane	(REE)PO ₄ •H ₂ O
Synchysite	Ca(REE)(CO ₃) ₂ F
Thalenite-(Y)	Y ₃ Si ₃ O ₁₀ OH
Xenotime	YPO ₄

¹A 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.

Rare-Earth Elements

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

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.”



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)

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-Wuerttemberg
(530.15) North Rhine-Westphalia
(Nordrhein-Westfalen)
(530.16) Hessen
(530.17) Schleswig-Holstein
(530.18) Saarland

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

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

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/>

Examples:

MRDS: <https://mrdata.usgs.gov/mrds/find-mrds-graded.php>

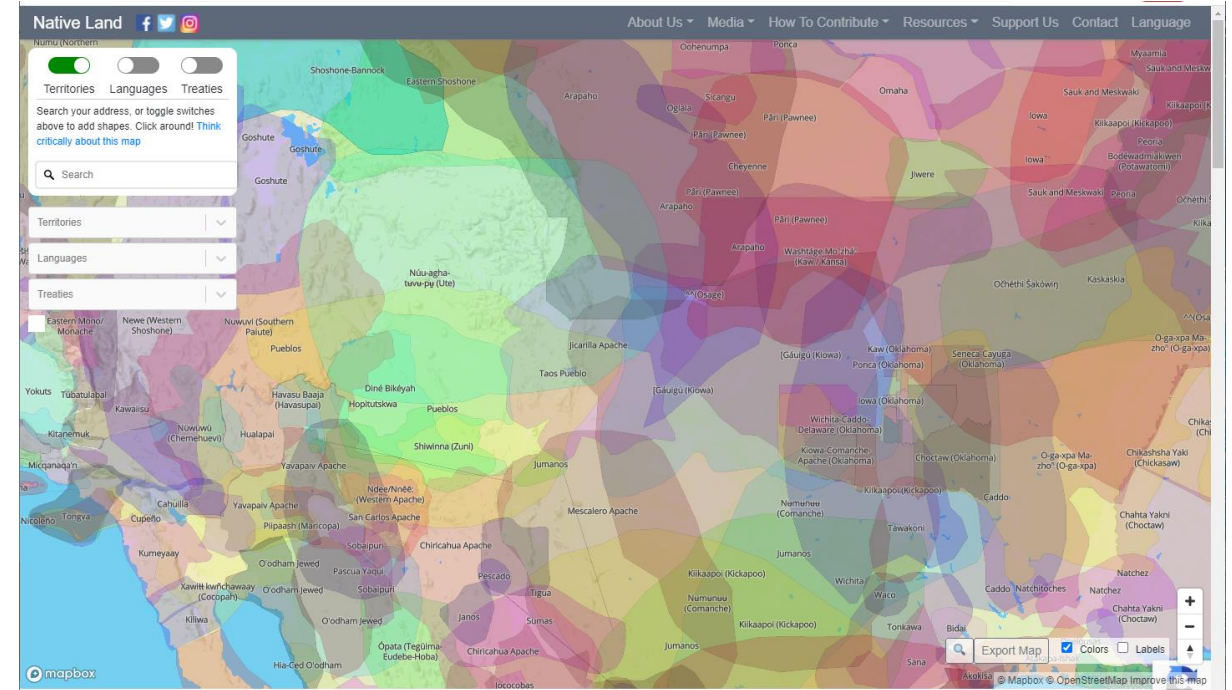
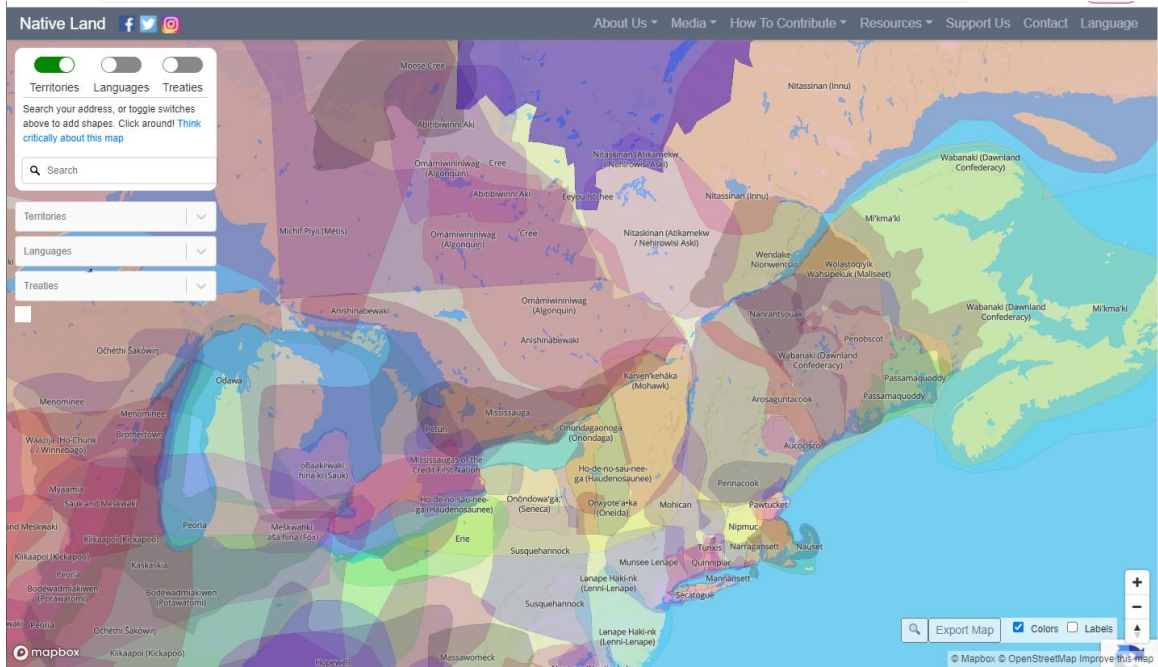
Earth MRI, Critical Minerals – Focus Areas: <https://mrdata.usgs.gov/earthmri/focus-areas/>



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

<https://native-land.ca/>

Indigenous Communities



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



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

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>

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

