2021 – 2022

Building Mineral Literacy through STEM Education

groundWORK

Critical Minerals

Uranium Mine Site in Northern Canada

From A to Z: Minerals Critical for the Future

In March 2021, Canada released a list of 31 minerals considered critical for the sustainable economic success of Canada and of its global partners. The 31 minerals, all of which are or can be produced in Canada, are essential to transitioning to a low-carbon economy, to domestic industry and security, and to ensuring a sustainable source of critical minerals for our global partners. They are minerals necessary for renewable energy technologies, manufacturing, aerospace and defence, information and communications technology, agriculture, health and life science applications, and critical infrastructure.

Canada's Critical Minerals List

- Al Aluminum
- Sb Antimony
- Bi Bismuth
- Cs Cesium
- Cr Chromium
- Co Cobalt
- Cu Copper
- F Fluorspar
- Ga Gallium
- Ge Germanium
- C Graphite
- He Helium
- In Indium
- Li Lithium
- Mg Magnesium
- Mn Manganese
- Mo Molybdenum
- Ni Nickel
- Nb Niobium
- Pt Platinum group metals
- K Potash
- REE Rare Earth Elements
- Sc Scandium
- Ta Tantalum
- Te Tellurium
- Sn Tin
- Ti Titanium
- W Tungsten
- U Uranium
- V Vanadium
- Zn Zinc

Contents

So where does Canada place globally in the production of so many of these critical minerals? From aluminum to zinc, Canada is already a global leader in responsible and sustainable exploration and mining. Our federal, provincial, and territorial governments are collaborating to position Canada as a global supplier for clean and advanced technologies.

1ST Canada places 1st as the world's largest producer and exporter of **potash**, sourced from Saskatchewan and primarily used in fertilizers that help grow food around the world.

2ND Saskatchewan also puts Canada in 2nd place as a producer of **uranium**, most commonly used in the nuclear power industry to generate electricity. Ontario and Quebec make Canada the 2nd largest producer of **niobium**, used to make high-strength steel for industrial, infrastructure, and high technology applications.

3RD Canada takes 3rd place globally for the production of **palladium** and **titanium**. Palladium, one of the platinum group metals and sourced mainly in Ontario, plays a key role in pollution-control devices for cars and trucks. Titanium, mined in Quebec, is turned into titanium dioxide, used in paints, papers, milk, toothpaste, rubber, plastics, cosmetics, sunscreen, and many food products to improve whiteness, brightness, and texture.

4TH Canada is the world's 4th largest producer of **aluminum**, refined from imported bauxite, and used extensively in the automotive industry, as well as construction, electronics, and packaging. Hydroelectric capacity and innovative technologies in British Columbia and Quebec achieve the lowest global carbon footprint compared to other large producers.

4TH Canada also places 4th in producing **indium** and **platinum**. Indium, sourced mainly in British Columbia and Ontario, is used to make indium tin oxide, key to touch screens, flatscreen TVs, and solar panels. Platinum, the most familiar of the platinum group metals, is mostly mined in Ontario as a byproduct of nickel mining. Platinum goes into catalytic converters, which reduce automotive pollution, and other industrial and medical applications.

5TH And 5th place goes to… Canada for the production of **graphite** and **nickel**. Graphite, mainly mined in Quebec, is used in electrodes, batteries, and solar panels. Nickel, mined mostly in Ontario, followed by Quebec, Newfoundland and Labrador, and Manitoba, largely ends up in stainless steel. It's also used as an alloying agent, for electroplating, and in both nickel-cadmium batteries and lithium-ion batteries for electric and hybrid vehicles.

5TH Canada also has the 5th largest **helium** resource in the world. Saskatchewan holds significant underground reserves, as well as numerous refineries. Not just for party balloons, helium acts as a coolant for superconducting magnets and satellite instruments, and it provides an inert protective atmosphere for making fibre optics and semiconductors, and for arc welding.

5TH **Tellurium**, with Canada being 5th in refinery production globally, has applications in solar panels, rubber production, electronics, and more. Ultra-high purity tellurium, produced in British Columbia, can be used for semiconductor technologies used in medical imaging, advanced security and military systems, and for next generation solid-state batteries for use in electric vehicles, cell phones, computers, and other electronics.

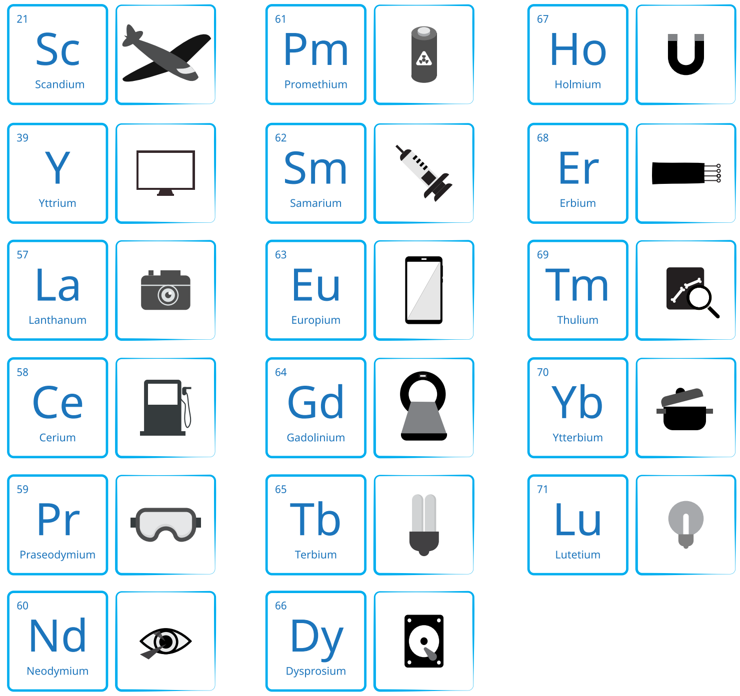
6TH Canada is also a major producer of **cobalt**, placing 6th in world production. Mainly produced in Ontario and Newfoundland and Labrador, cobalt is mostly used in lithium-ion batteries. It is also goes into electronic devices and batteries, and other applications, from jet engines to hip replacements.

7TH 7th place for **fluorspar** mining belongs to Canada. Mined in Newfoundland and Labrador, fluorspar is used in the metallurgical, ceramics, and chemical industries. It is key to producing hydrofluoric acid, one of the most commonly used commercial chemicals; in processing of uranium and aluminum; and to manufacturing enamels, glass, and fibreglass, as well as steel and Portland cement.

8TH Canada ranks 8th in the world in producing **zinc**, mined in Manitoba, Ontario, Quebec, British Columbia, and New Brunswick. Zinc is used primarily in galvanizing to protect iron and steel from rusting. It also goes into zinc alloys, including brass and bronze, for die-castings in the automobile, electrical, and hardware industries.

Canada also produces significant amounts of **copper** and **molybdenum**. Copper, predominantly from British Columbia and Ontario, and with projects in Nunavut and the Northwest Territories, goes into electrical wires and cables, plumbing, industrial machinery, and construction materials, as well as clean technologies, like solar cells and electric vehicles. Molybdenum, mostly from British Columbia, is used principally to alloy with steel, cast iron, and superalloys.

Rare earth elements (REEs), a group of 15 elements, and **lithium**, key components of cell phones, computers, and other everyday devices, are also critical for energy storage and clean energy technologies such as solar cells, high-density batteries, and wind turbines. Canada has some of the largest known reserves of REEs in the world, with projects in British Columbia, Quebec, Saskatchewan, and Labrador. It also has many REE firsts on the horizon; the first mine in The Northwest Territories; the first Canadian processing facility, being built in Saskatoon; and the world's first sustainable recycling facility, being built in Quebec. As for lithium, Canada is poised for major production, with over 30 exploration projects in Quebec, Ontario, Manitoba, and Alberta.



Antimony, mined in New Brunswick and Newfoundland and Labrador, is widely used as a flame retardant. It is also an important alloy metal in lead-acid and lithium-ion batteries, military applications, and tungsten steel, and is a key ingredient in semiconductors, circuit boards, electric switches, fluorescent lighting, and high-quality clear glass.

Bismuth, produced in the Northwest Territories, is used in medicine, cosmetics, low-melting alloys, fire detection/extinguishing systems, and in bullets.

Cesium, extremely rare globally, is mined in Manitoba and occurs in significant deposits in Ontario. Used in oil drilling lubricants and highly accurate atomic clocks, it is also vital for the data transmission infrastructure of mobile networks, GPS, and the internet.

Chromium is used in the fabrication of ferrochrome, necessary to produce stainless steel. Chromium alloys are used to plate auto parts, appliances, and other products, and as superalloys in jet engines. Ontario has world-class chromite deposits under development.

Gallium, obtained from bauxite and zinc ores, is used in high-tech applications such as 5G wireless networks, smartphones, laser diodes, semiconductors, solar energy magnetic materials, and military devices. In Canada, gallium has been found in a promising REE deposit in Saskatchewan and is also recycled from scrap metal.

Germanium, refined in British Columbia from zinc concentrates, is used in optical lenses, fibre optics, infrared applications, semiconductors, and solar cells.

Magnesium, with deposits in British Columbia and extracted from mine tailings and scrap in Quebec, is principally used for the automotive industry. It also goes into alloys used in aerospace and medical applications, transportation, agriculture, batteries, and construction.

Manganese is the fourth most widely used metal in the world, with nearly 90 per cent used in steel making. Applications also include lithium-ion batteries, utility bulk energy storage facilities, fertilizers, animal food, and glass. New Brunswick hosts what might be the largest deposit in North America, currently under evaluation.

Scandium is principally used for solid oxide fuel cells and high performance aluminum-scandium alloys used in the auto and aerospace industries. Other uses include ceramics, electronics, lasers, lighting, and radioactive isotopes. In Quebec, a breakthrough method has been developed to recover scandium from titanium processing byproduct.

Tantalum, once mined in Manitoba, now with exploration projects in Ontario, Quebec, and the Northwest Territories, makes it possible to store electricity in miniature capacitors used in aviation electronics, computers, and hand-held electronic devices such as cell phones.

Tin, mined in Nova Scotia, is used for plating, coating, and polishing; solders; flat panel displays; alloys such as bronze and copper; battery electrodes; dental applications; and marine applications.

Tungsten, with projects in the Yukon, the Northwest Territories, and British Columbia, primarily goes into tungsten carbide, ideal for cutting and wear-resistant applications in construction, metalworking, mining, and oil and gas drilling. It also goes into various alloys and specialty steels; aerospace and defence applications; electrical, electronic, heating, lighting, and welding applications; and various chemical applications.

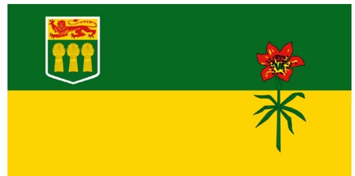
Vanadium, with significant deposits in Quebec, is primarily used in high strength steels used in construction, auto parts, heavy equipment, industrial tools, medical devices, turbine engines, and military vehicles. Emerging vanadium redox flow battery (VRFB) technology is a promising way to store energy from renewable sources.

With numerous operating mines and a wealth of projects under evaluation or development, Canada is well on its way to meeting objectives to become a supplier of choice.

Mining Needs You: A New Mining Career Resource

The Mining Industry Human Resources Council has launched a new mining career awareness website directed toward youth. An excellent resource for career educators, the website provides up-to-date information about the wide range of career paths available in this dynamic industry. The information presented connects mining to materials and manufacturing, technology, medicine, and renewable energy generation, and describes modern mining with its focus on environment and sustainability, occupational health and safety, and use of technology. The website provides career exploration resources, including career profiles, and an interactive career pathway that directs seekers to opportunities in skilled trades, science and technology, management, and more. miningneedsyou.ca/

Mining Matters in Saskatchewan



Sponsored by the International Minerals Innovation Institute, Mining Matters and the Saskatchewan Mining Association have partnered to create a classroom resource for Saskatchewan educators. Focusing on Earth science and mineral resources education, the resource will incorporate lesson plans and other content from Mining Matters *"Deeper and Deeper"* resource for grade 4, and the Saskatchewan Mining Association's "Mining Inquiry Project," Potash Kits, and Rock Cycle Journey and Mineral Deposits lesson plans. Professional learning workshops are planned for the upcoming academic year. Please visit the Mining Matters website for more information and to complete your registration.

Rocks + Kids = Opportunities

Mining Matters continues to provide specialized learning for students and teachers in underserved schools in the Greater Toronto Area and across Canada. Sponsored by Kinross Gold Corp., the *Rocks + Kids = Opportunities* program is connected to the curriculum and available at no cost to eligible schools. The program offers Earth science and mineral resources education workshops to students in grade 4 and provides each participating school with a set of teacher and student resources. Workshops can be customized, providing teachers with the opportunity to select from a series of four workshop topics - rocks, minerals, mining and the use of mineral resources in everyday life. For the 2021/2022 academic year, workshops will be delivered virtually. In-person workshops might be available later in the academic year as COVID-19 restrictions lift. Mining Matters continues its formal partnership with the Toronto District School Board to offer this program to their Model and Priority Schools. The program is available to all school boards with eligible schools. To learn more about *Rocks + Kids = Opportunities* or to request a workshop, contact schoolprograms@miningmatters.ca.

Sponsored by Teck

WHERE Challenge

The 2021/2022 edition of the WHERE Challenge launches in September! The Challenge provides an opportunity for students ages 9 to 14 to discover the role that mineral resources play in their daily lives. Through the contest, students learn about non-renewable resources, including from where they are sourced and how they are used. A total of $5,000 in cash and prizes is available to be won. All entries must be submitted online by March 4, 2022. Please visit the WHERE website wherechallenge.ca/ for contest rules and to see a list of 2020/2021 winners and to see their winning entries. To learn how you can participate in the current WHERE Challenge or to request a WHERE workshop, please email WHEREChallenge@miningmatters.ca.

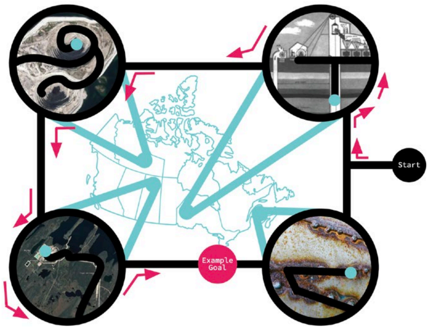
Water Hazards Energy Resources Environment

Deeper and Deeper Video Tutorials

Are you a grade 4 teacher who has participated in an in-person *Deeper and Deeper* instructional development workshop? Are you interested in refreshing your mineral and rock identification skills? Visit the Mining Matters website to review a series of training videos that present select learning activities from the resource.

Mining Matters Escape Room

With the generous sponsorship of Teck Resources Limited and the technical expertise of SenseTech Solutions (sensetech.ca), Mining Matters has developed a virtual Escape Room. Designed to generate interest in and teach about Earth sciences and the mining industry, the exciting three-part challenge can be accessed using screen readers. The game is themed around a character called Dragon Sodalite, who has claimed a mine and its contents as part of its hoard. According to the *Dragon Code of Ethics*, an opportunity must be provided for challengers to reclaim what it has taken. Visit the Mining Matters website to learn how to play the game. miningmatters.ca/about-us/instagram/escape-room

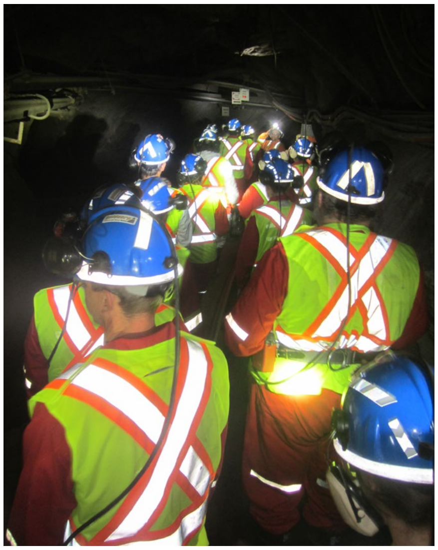


Robotics Rocks!

The Robotics Rocks activity introduces students in grades 6 to 8 to the mining industry and robotics. Developed by Mining Matters in collaboration with a Master's candidate from Ontario Tech University, the activity helps to connect middle school students to the technology and innovation used in the mining industry, and also to programming aspects in the Math curriculum. Designed to spark curiosity, it also serves to build resilience (experiencing failure before success), literacy skills, team building, and communication. Use of the activity can be flexible, with online/virtual and in-person adaptations. The online/virtual modules can even be run without robots.

Mineral Resources and Mining Education Tours: Professional Learning for Teachers

Since 2010, Mining Matters, the Ontario Mining Association, the Canadian Ecology Centre, and the Canadian Institute of Mining, Metallurgy and Petroleum have partnered to deliver Mineral Resources and Mining Education Tours, an experiential professional learning program for formal and informal educators from across Canada, and mineral development advisors. The tours are delivered in Ontario annually in late summer, or by request, during the academic year. There are three different tours included in the program that can be scaffolded:



Mineral Resources and Mining Education Foundations

This tour program provides a foundational understanding of Earth science and mineral resources, including the fundamentals of mineral and rock identification and the early phases of the mine life cycle, including prospecting. Participants tour North Bay mineral exploration and mining supply and service providers.

Mine Life Cycle

Participants learn about the phases of the mine life cycle and explore the geology and history of the Sudbury region, known globally for nickel production, or the Timmins area, known globally for gold production. The program includes visits to an underground mine and reclamation sites, engagement with industry professionals, and hands-on instructional development workshops focusing on Earth science and mineral resources.

Life in a Mining Camp

Participants tour underground and surface operations, including the mine and mill, and stay overnight at the Impala Canada's Lac des Iles Mine, located north of Thunder Bay.

The tours are fully subsidized and available for a fee of $50 per tour. Registration includes transportation, accommodation, and meals, while on site. Participants are responsible for all expenses incurred travelling to and from tour locations (i.e., the Canadian Ecology Centre or the Thunder Bay International Airport). Visit the Canadian Ecology Centre website for additional details and to complete your registration. canadianecology.ca/professional-development/miningtour)

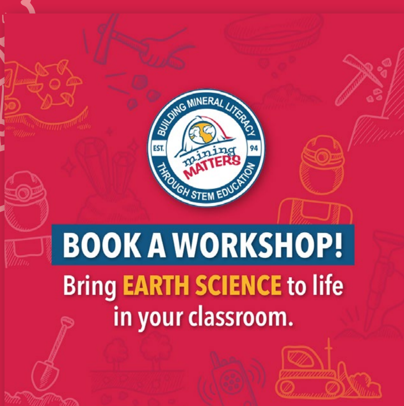
Mining Matters Resources

GEMS

Launched in 2020 to support the transition to online learning at home, Mining Matters GEMS, “Do it Yourself” Geology, Engineering, Mining, and Sustainability themed educational activities, are directed toward children and families. In 2021, more activities were added to our DIY activity collection. The activities are well suited for learning at home, with easy-to-understand instructions and easily sourced materials. They also make an excellent addition to STEM learning activities for educators who are teaching remotely. miningmatters.ca/resources/education/gems---diy-activities

Virtual Geoscience Workshops

Engage Mining Matters to support your virtual Earth science teaching. We now offer workshops that will challenge your students to identify properties of Earth materials, engage them in lively discussions, and better their understanding of where and how these resources form. Students will actively develop critical thinking skills and apply inductive and deductive reasoning to identify a variety of samples. Mining Matters geoscience workshops for students include local and regional perspectives by showcasing samples that are sourced in Canada. Workshops can be adapted as required, for example, as introductory sessions to activate prior knowledge or to complement or reinforce concepts, topics, and theories previously introduced. The cost is $3 per student and hands-on kits are available for an additional fee of $9. Contact schoolprograms@miningmatters.ca for more information.



Mining Matters Grade 4 Workshops Themes:

Minerals

Students will learn the difference between rocks and minerals, conduct tests geologists use to examine the physical characteristics of minerals, use their observations to identify mystery minerals and gain an understanding of how minerals are used in daily life. Additional hands-on kit: mineral testing equipment and a mystery mineral sample.

Rocks

Explore the rock cycle, gain an understanding of how each of the three rock groups are formed through a series of demonstrations, discover some of the clues to look for to help determine which of the rock group a rock is from, and then use those clues to identify a mystery rock. Additional hands-on kit: mystery rock sample, magnifying glass and materials to create a model of one of the three rock groups.

Mining

Explore the mining cycle, compare and contrast surface and underground mines, discuss the costs and benefits of mining, and learn about responsibilities to the environment and communities. Additional hands-on kit: cookie mine, satellite image of a landscape, play money, mining tools, an environmental permit and a rock sample.

What on Earth is in your stuff?

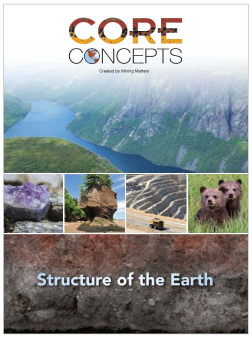
Examine maps to locate where rocks, minerals and metals are found in Canada. Learn that everything in our world that isn’t grown is made using non-renewable resources that are extracted from the Earth. Work in teams to develop and present a short story that connects rocks, minerals, metals to your everyday life. Discuss finite resources and the importance of conservation by reducing, reusing, recycling and being a responsible consumer. Additional hands-on kit: card game “What’s Yours is Mined”, copper wire to create a metal sculpture, and four mini samples of minerals used in everyday life. To book a workshop, visit MiningMatters.ca.

Mining Matters Classroom Resource Kits

Classroom Resource Kits are developed in collaboration with educators and technical specialists to meet provincial Earth science and Geography curriculum mandates and guidelines. Kits include lesson plans, black line masters, mineral and rock samples, equipment, and student visuals. Three resource kits are available for use across Canada:

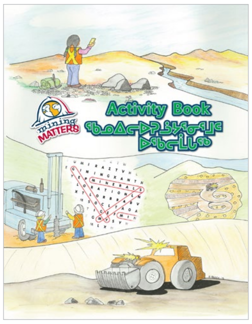
- Junior/Elementary: *Deeper and Deeper: Discovering Rocks and Minerals*
- Intermediate/Middle: *Core Concepts*
- Senior/Secondary: *Discovering Diamonds*

Resource kits are available in both official languages through a prerequisite in-service workshop, available virtually. Workshops can be scheduled for groups of 10 to 24 teachers, anywhere in Canada, given four weeks' notice. Learn more about these resources and how to access them at miningmatters.ca/school-programs/teachers



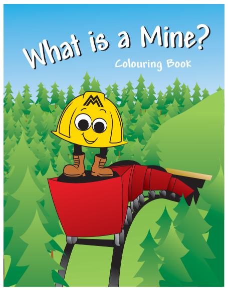
Core Concepts

Core Concepts are a series of classroom-ready activities that reflect key foundational ideas in Earth science, including the structure of the Earth, rocks and minerals, soil and erosion, the mining cycle, and social and environmental responsibilities.



Mining Matters Activity Book

Created for youth ages 9 to 13 years, this activity book is full of fun activities, including puzzles, codes to crack, things to spot, word searches, crosswords, Sudoku, and more. Available in English, French, Inuktitut, Inuinnaqtun and Spanish, it supports learning about minerals, rocks, metals, mining, and minerals industry careers.



What is a Mine?

This colouring book features Mighty Miner, who guides students through an adventure that helps them learn about mining.

Mining Makes It Happen Posters

This series of five MMIH posters helps students understand the role that rocks, minerals, metals, and elements play in manufacturing, medicine, sports, music, and energy. The posters are available in English, French, Ojibway, Cree, and Oji-Cree. A new poster is in the works that will focus on Canada's list of 31 minerals considered critical for the sustainable economic success of Canada and of its allies.

Other Resources

Podcasts

The Traveling Geologist website features a series of geoscience-themed podcasts suitable for a secondary school audience. The "Story Book Earth" podcasts, narrated by Geologist Dr. Jess Kapp, combine science and storytelling to describe Earth's history, features, and processes, including glaciation, tectonics, and rocks. The "Gneiss Chats" podcasts feature interviews with geoscientists from a range of fields, including green mining, Earth evolution, paleo magnetism, and more. The "Geological Expeditions of Yore" podcasts tell the stories of important historical figures in geoscience, including Alice Wilson, celebrated woman geologist, and Tuzo Wilson, a Canadian geoscientist recognized globally for his contributions to the theory of plate tectonics. In the "Backyard Geology" podcasts, students learn about amazing geologic discoveries in people's backyards, including Pleistocene fossil mammals, diamonds, meteorites, and more! travelinggeologist.com/geology-podcast-network/

Videos

The Traveling Geologist TV website features a series of videos, including "Geology of the Future." Each episode, narrated by undergraduate student Meghan Zee, examines an element of the mine life cycle, along with the geologic, economic, social, and environmental aspects of iron mining. travelinggeologist.com/tgtv/

Websites

Critical Minerals Mapping Initiative

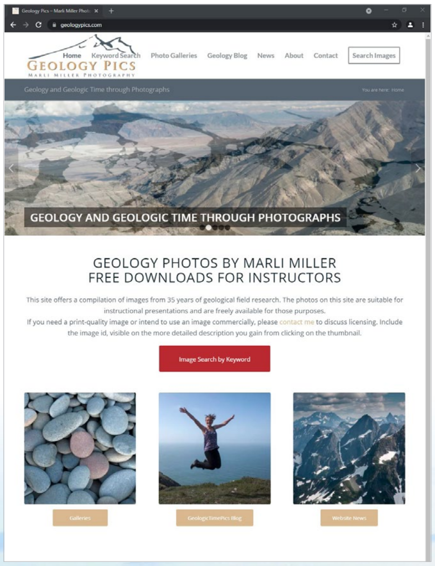
The Critical Minerals Mapping Initiative (CMMI) Portal is a free interactive mapping tool designed to share outputs from the geoscientific collaboration between Geoscience Australia (GA), the Geological Survey of Canada (GSC), and the United States Geological Survey (USGS). Focused on building a diversified critical minerals industry in Australia, Canada, and the United States, the CMMI is developing a better understanding of:

- known critical mineral resources
- geologic controls on critical mineral distribution for deposits currently producing by-products
- how to infer new sources of supply through critical mineral potential mapping and quantitative mineral assessments.

The portal includes resources for teachers and students including presentations, webinars, and videos. portal.ga.gov.au/persona/cmmi

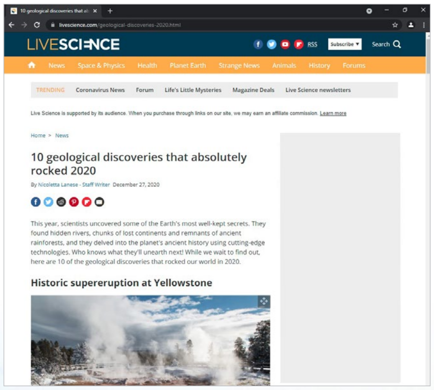
Geology Pics: Marli Miller Photography

This site offers a compilation of images from 35 years of geological field research. The photos are suitable for instructional presentations and free to download by instructors. geologypics.com



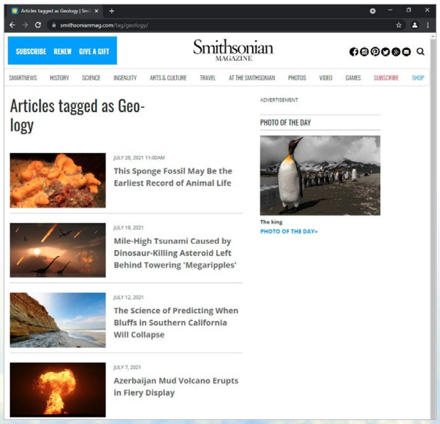
10 Geological Discoveries that Rocked 2020

In 2020, scientists uncovered some of the Earth's most well-kept secrets. They found hidden rivers, chunks of lost continents, and remnants of ancient rainforests, and they delved into the planet's ancient history using cutting-edge technologies. livescience.com/geological-discoveries-2020.html



Smithsonian Magazine

Smithsonian Magazine is the official journal published by the Smithsonian Institution in Washington, D.C. First published in 1970, it places a Smithsonian lens on the world, looking at the topics and subject matters researched, studied, and exhibited by the Smithsonian—science, history, art, popular culture, and innovation—and chronicling them every day for their diverse readership. Articles tagged as Geology chronicle the latest geologic and investigations and discoveries. smithsonianmag.com/tag/geology/



Did You Know?

The Maritimes Came from the Southern Hemisphere

The Maritimes are made up of parts of the Earth's crust that originated in the Southern Hemisphere, as far south as the South Pole. It turns out that most of the older rocks of Nova Scotia and southern New Brunswick originated on microcontinents (what geologists call terranes) that were located in the "deep south" 400 to 550 million years ago. This contrasts with southern Ontario, for example, which is mainly underlain by large tracts of flat-lying limestone. Read more at science.gc.ca/eic/site/063.nsf/eng/97509.html

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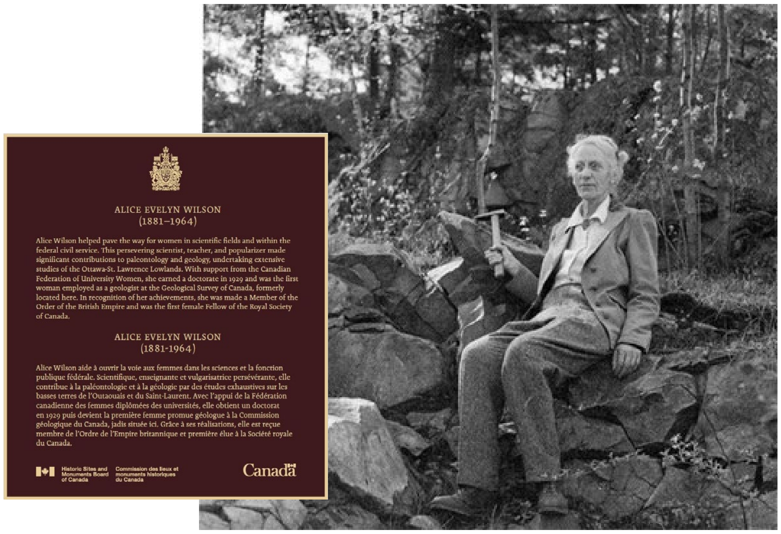
First Female Geologist Hired by the Geological Survey of Canada

Alice Wilson was a lot of firsts. Born in Cobourg, Ontario, in 1881, she became the first female geologist hired by the Geological Survey of Canada, admitted to the Geological Society of America, and made a Fellow of the Royal Society of Canada. She mapped over 14,000 square kilometres of the Ottawa-St. Lawrence Lowlands, complete with information on the geology and fossils found in this region — and she did it alone, because the Geological Survey of Canada barred her from doing fieldwork with men. Read more at massivesci.com/articles/alice-wilson-geology-paleontology-science-hero/



Earth Vibrates Less During COVID-19 Lockdown

An article in science journal Nature, in March 2020, states that vibrations within the Earth were reduced by about a third during the global lockdown to stop the novel coronavirus pandemic. According to seismologist Thomas Lecocq, of the Royal Observatory of Belgium, a drop in seismic noise—the hum of vibrations in the planet's crust—could be the result of transport networks, industrial activity, and other human activities being shut down. A noise reduction of this magnitude is usually only experienced briefly around Christmas. Reduced vibration allows detectors to spot smaller earthquakes and boost efforts to monitor volcanic activity and other seismic events. Read more at nature.com/articles/d41586-020-00965-x

Discovery of New Geologic Process Calls for Changes to Plate Tectonic Cycle

Geoscientists at the University of Toronto and Istanbul Technical University have discovered a new process in plate tectonics that shows that tremendous damage occurs to areas of Earth's crust long before it should be geologically altered by known plate-boundary processes, highlighting the need to amend current understandings of the planet's tectonic cycle.
sciencedaily.com/releases/2021/05/210511160718.htm

James Hutton: The Founder of Modern Geology

James Hutton (1726–1797), a Scottish farmer and naturalist, is known as the founder of modern geology. He was a great observer of the world around him and made carefully reasoned geological arguments. Hutton came to believe that the Earth was perpetually being formed; for example, molten material is forced up into mountains, eroded, and then eroded sediments are washed away. He recognized that the history of the Earth could be determined by understanding how processes such as erosion and sedimentation work in the present day. His ideas and approach to studying the Earth established geology as a proper science.
amnh.org/learn-teach/curriculum-collections/earth-inside-and-out/james-hutton

Geologists Find Lost Fragment of Ancient Continent in Canada's North

A chance discovery by geologists poring over diamond exploration samples has led to a major scientific payoff. Sifting through samples from Baffin Island, Canadian scientists have identified a new remnant of the North Atlantic craton—an ancient part of Earth's continental crust. Read more at science.ubc.ca/news/geologists-find-lost-fragment-ancient-continent-canada%E2%80%99s-north

Field Trips

Field trips provide enriching experiential Earth science learning opportunities for students.

Canadian Museum of Nature

In October 2020, the Canadian Museum of Nature, located in Ottawa, Ontario, announced the acquisition of a significant scientific collection of minerals; the Gilles Haineault Mont Saint-Hilaire Collection comprises more than 8,000 specimens. Of these, 1,160 were assessed by the Canadian Cultural Property Export Review Board as meeting the criteria of "outstanding significance and national importance."

Geological collections have been at the Canadian Museum of Nature since 1965. Their comprehensive collections of minerals, gems, deposit suites, and rocks comprise more than 60,070 specimens. Researchers and graduate students from Canada and abroad depend on these collections to form the foundation for their research projects. nature.ca/en/research-collections/collections/minerals

UNESCO Global Geoparks Network

In July 2020, two Atlantic Canada sites were recognized as UNESCO Global Geoparks.

The Cliffs of Fundy UNESCO Global Geopark contains over 40 geosites across 125 km where visitors can see the Earth's natural history, the world's highest tides, and Canada's oldest dinosaur fossils. Visitors can also discover the legends and cultures of the Mi'kmaq, who inhabited the area for more than 11,000 years.

Cliffs of Fundy Geopark

The Discovery UNESCO Global Geopark, located on Newfoundland's Bonavista Peninsula, provides its visitors with a chance to learn about the earliest fossils of animal life and to explore seascapes.

DISCOVERY GLOBAL GEOPARK
HALF A BILLION YEARS IN THE MAKING

Geoparks include sites of geological, archeological, wildlife, environmental, historical, folkloric, and cultural interest. There are currently 147 UNESCO Global Geoparks in 41 countries, five of them being in Canada. Cliffs of Fundy and Discovery joined three other UNESCO Global Geoparks in Canada: Stonehammer (New Brunswick), Percé (Québec), and Tumbler Ridge (British Columbia). Together with their communities, Canadian geopark leaders:

- encourage sustainable tourism
- enhance awareness and understanding in youth and visitors about the area's geological heritage and history
- protect the geopark's unique environment
- promote Earth science research

en.unesco.org/news/geopark-2020

Virtual Field Trips

Volcano World

Teachers are invited to join the Volcano World team, along with volcanologists and adventurers from around the world, as they explore and photograph the world's volcanic areas. This website, hosted by Oregon State University, features seven virtual field trips. Take your students on an adventure, exploring volcanoes in Greece, Japan, Indonesia, and the United States. volcano.oregonstate.edu/adventures-and-fun/virtual-volcano-fieldtrips

The Niagara Escarpment

Learn about the geology of this prominent Ontario landform through a series of 11 field trips created by faculty, students, and staff from the McMaster University, School of Earth, Environment and Society. Each field trip includes a downloadable file that highlights important geologic features found at that location, a schematic of the formations visible at the site, maps, diagrams, and photos. science.mcmaster.ca/ees/outreach/sges-outreach.html#virtual-field-trips-to-the-niagara-escarpment

Micro My Earth Virtual Field Trips

Access geological outcrops and experiences around the world from your home or classroom. Micro My Earth features 80 geological field trips, most of which are easily accessible and require no special software apart from Google Earth, in some cases. They span from the iconic volcanic landscape of Iceland to the fossil-rich hills of central California. Also included are a virtual flight around Nova Scotia, a look at sites around Vancouver, British Columbia, and exploring 14 Alberta landscapes and geological features. Some virtual field trips are simple images with accompanying text, while others are full 3D experiences.
micromyearth.com/virtual-field-trips

GeoscienceINFO

This series of 17 geologically themed field trips is an excellent resource for teachers. Take your students to locations across Ontario and Quebec that feature important mineral discoveries, ancient ocean environments, and past catastrophic events like explosive volcanoes, giant meteorite strikes, glaciation, and more. geoscienceinfo.com/virtual-field-trips.html

Geoscience INFO .COM
FUNDED BY APGO EDUCATION FOUNDATION

Conferences

The Geological Association of Canada, along with the Mineralogical Association of Canada, the International Association of Hydrogeologists – Canadian National Committee, and the Canadian Society of Petroleum Geologists will host a joint conference in Halifax in May 2022. The conference program will include a Geoscience Education Technical Session, an Educator of Professional Learning Program, and a Field Trip to the Cliffs of Fundy UNESCO Global Geopark. Visit the conference website for more information about the conference, including how to complete your registration. halifax2022.atlanticgeosciencesociety.ca/

More Resources

Minecraft: Education Edition

Explore game-based learning with Minecraft Education Edition. Minecraft is an immersive learning platform that promotes students' creativity, collaboration, and problem-solving. The Education Edition offers training and resources for teachers, including lesson plans; subject kits, such as science, mathematics, language arts, history and culture; and more! Visit the website to learn more.
education.minecraft.net/en-us/homepage

ROM Minecraft

The ROM developed a Minecraft server where students can create meaningful, personalized learning across a wide variety of themes, including science, resource use, and community. A recent development includes a hybrid learning Minecraft program that teachers can host in their own classrooms.

The ROM Minecraft program is designed to support curriculum expectations from the Coding strand of the Ontario Mathematics Curriculum. The Museum Math: Rocks and Minerals program supports expectations from the grade 4 Rocks and Minerals strand of the Ontario Science Curriculum. Virtual visits are coordinated with a ROM Educator at key progress points during the program.

Students begin their journey in the Royal Ontario Museum's research centre in the fictional world of Rocklandia. From there, they travel to three different research sites to help ROM scientists with their studies of igneous, sedimentary, and metamorphic rocks. Students will encounter challenges that block their path and that they need to code their way through with the support of Indigenous scientists and the Minecraft agent. After visits to the three research sites, students return to the research centre and create their own museum where they share their learning about rocks and minerals. This program is designed for students to complete individually or in pairs. Schools must provide their own devices. Visit the ROM website for more details about the program.
rom.on.ca/en/learning/rom-minecraft

Canadian Geographic Educator Resources

The Canadian Geographic Education website hosts K to 12 resources featuring topics ranging from science and technology, climate change and the environment, development and sustainability, energy and natural resources, regional geography, geographic skills, and more. Visit the website and use the searchable database to find free, bilingual lesson plans. cangeoeducation.ca/en/resources/?resource-types=lesson-plans

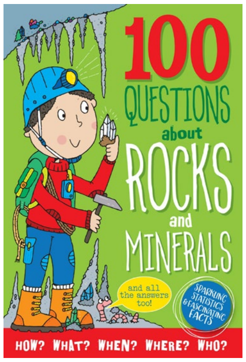
Careers in Mining

Hosted on the Modern Mining and Technology Sudbury website, Careers in Mining showcases 33 mineral industry professionals from a wide range of workplaces, each answering the questions:

- Why a career in mining?
- Why do you love your job?
- What are the benefits to a career in mining?

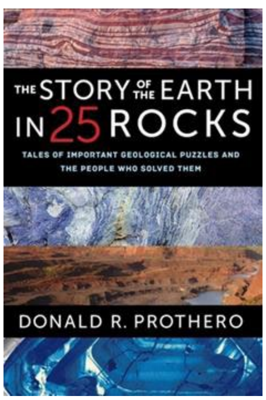
Students can explore careers in geology, hydrogeology, chemistry, environmental science, engineering, business, and education.
modernmining.ca/resources/why-i-love-mining

Books



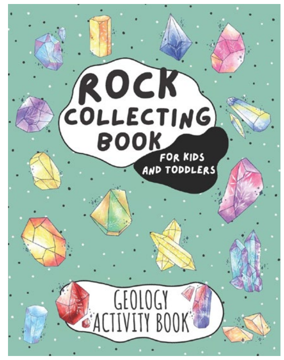
100 Questions About Rocks & Minerals
by Peter Pauper Press (2019)

In this question-and-answer adventure, kids can dig deep to discover all there is to know about the hidden gems of our own planet. What is the difference between a rock and a mineral? What makes a gemstone a gemstone? Which minerals might they encounter every day without even knowing it? They can find the answers in this colourful illustrated book, packed with fascinating facts and sprinkled with jokes and puns!



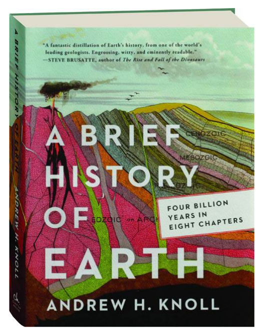
The Story of the Earth in 25 Rocks: Tales of Important Geological Puzzles and the People Who Solved Them
by Donald R. Prothero (2020)

Read the fascinating stories behind the discoveries that shook the foundations of geology. In 25 chapters–each about a particular rock, outcrop, or geologic phenomenon–Donald R. Prothero recounts the scientific detective work that shaped our understanding of geology, from the unearthing of exemplary specimens to tectonic shifts in how we view the inner workings of our planet.



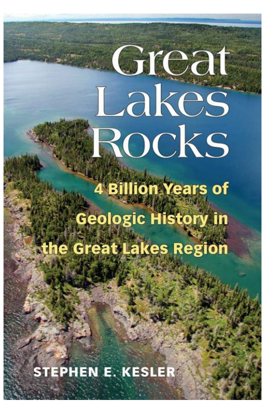
Rock Collecting Book for Kids and Toddlers
by Black Rock Publishing (2020)

This geology activity book will initiate kids and toddlers into the fascinating world of rock collecting while they have fun outdoors and go on countless adventures. Grab your backpack and book and go exploring to find the best rocks, minerals, and gems out there!



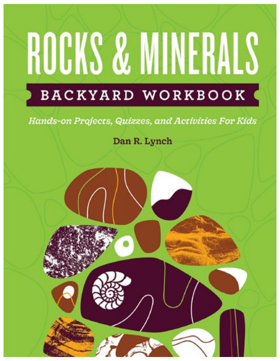
A Brief History of Earth: Four Billion Years in Eight Chapters
by Andrew H. Knoll (2021)

The story of our home planet and its organisms is far more spectacular than any Hollywood blockbuster, filled with enough plot twists to rival a bestselling thriller. But only recently have we begun to piece together the whole mystery into a coherent narrative. Drawing on his decades of field research and up-to-the-minute understanding of the latest science, renowned geologist Andrew H. Knoll delivers a rigorous yet accessible biography of Earth, charting our home planet's epic 4.6 billion-year story. Placing 21st century climate change in deep context, *A Brief History of Earth* is an indispensable look at where we've been and where we're going.



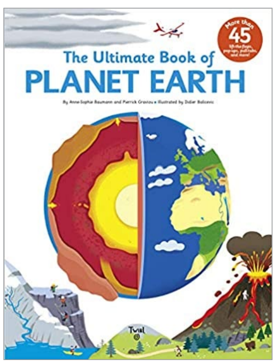
Great Lakes Rocks: 4 Billion Years of Geologic History in the Great Lakes Region
by Stephen E. Kesler (2019)

The geologic story of the Great Lakes region is one of the most remarkable of any place on Earth. *Great Lakes Rocks* takes readers on this fascinating journey through geologic history, beginning with an investigation of the surface features—the hills and valleys, waterfalls and caves, and the Great Lakes themselves. From there, the book digs deeper into the past, and readers learn about techniques geologists have used to reconstruct events that shaped this region millions and even billions of years before humans set foot on Earth. Throughout, the book gives special attention to the link between the region's geology and its modern history, including the impacts of geology on settlement patterns as well as the development of industries and the present-day economy.



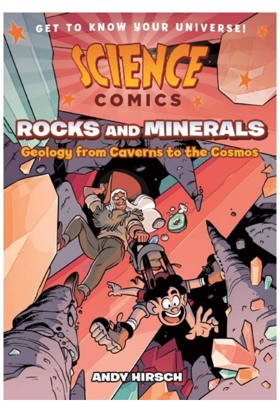
Rocks & Minerals Backyard Workbook: Hands-on Projects, Quizzes, and Activities for Kids
by Dan Lynch (2021)

This geoscience-themed workbook, for ages 4 to 8, features more than 20 simple, fun introductions to a variety of rocks and minerals, and more than a dozen activities to help young learners create hypotheses, experiment, and observe. This book is well suited for homeschools.



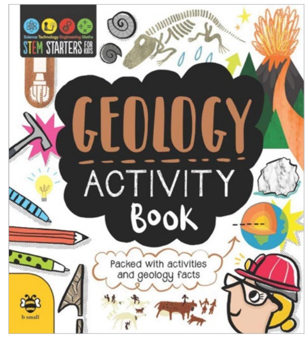
The Ultimate Book of Planet Earth
by Anne-Sophie Baumann, Didier Balicevic (Illustrator) (2019)

Learn all about our planet's geology, geography, atmosphere, weather, and more. Lots of flaps, pop-ups, pull-tabs, and rotating wheels bring mountain ranges, continents, and oceans to life. Readers will see all the layers of the Earth, learn how water flows from mountains to rivers to oceans, and understand our climate and weather patterns. Any child interested in nature and science will adore this extraordinary look at the world around us.



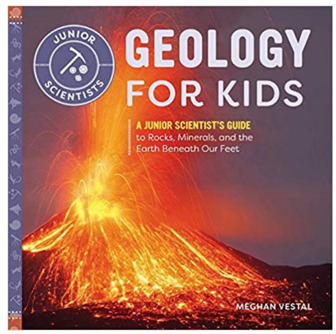
Science Comics: Rocks and Minerals: Geology from Caverns to the Cosmos
by Andy Hirsch (2020)

Science Comics is a graphic novel series created for a middle grade audience, ages 8 to 12. In this edition, readers learn about the forces that shape planet Earth, joining a famous rock hunter and a mineral enthusiast as they take a geological journey deep within the Earth, to the summit of a volcano, and into outer space.



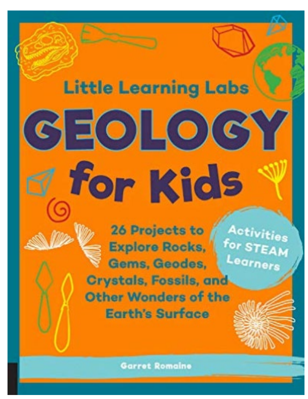
STEM Starters for Kids Geology Activity Book
by Jenny Jacoby (2019)

This book, appropriate for ages 6 to 10, will set the foundation for a solid background in STEM (Science, Technology, Engineering, Math) and geology. Young learners will explore and discover as they complete a series of activities.



Geology for Kids: A Junior Scientist's Guide to Rocks, Minerals, and the Earth Beneath Our Feet
by Meghan Vestal (2020)

Geology for Kids, for ages 6 to 9, includes facts, illustrations, and photos that will teach young learners how volcanoes erupt, why earthquakes shake the land, and what causes tsunamis. A photographic guide is included to help students identify the rocks and minerals in their collections.



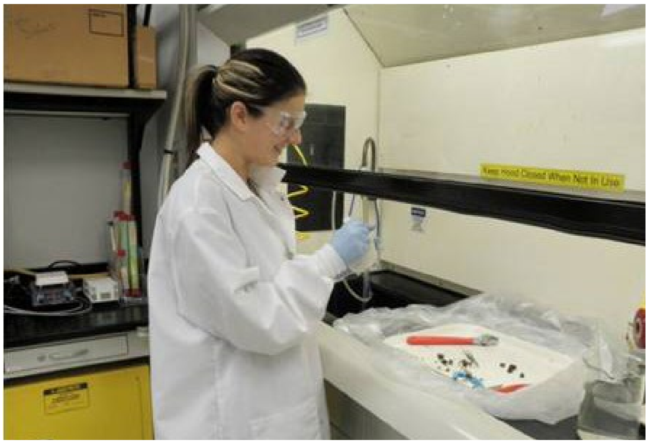
Little Learning Labs: Geology for Kids
by Garret Romaine (2019)

Little Learning Labs: Geology for Kids features 26 simple, inexpensive, and fun STEAM experiments that explore the Earth's surface, structure, and processes. Children explore the many wonders of geology, including crystal and fossil formation, the Earth's crust, and how water shapes landforms.

Career Spotlight

Lassonde Institute of Mining
UNIVERSITY OF TORONTO

Dr. Kelly Whaley-Martin
Research Scientist



Working in the laboratory

The Spotlight features an outstanding professional with the goal of raising career awareness among educators and their students. In this inaugural spotlight, we interview Dr. Kelly Whaley-Martin, an environmental biogeochemist who studies chemical, physical, geological, and biological processes and reactions in the natural environment.

What motivated you to choose a career in environmental biogeochemistry in particular?

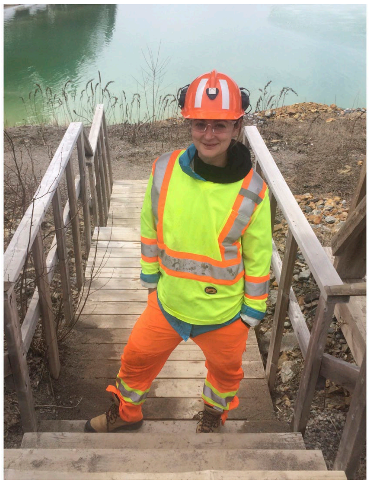
From the very first Earth science class I took in university, I was hooked. It was a discipline that truly required a holistic way of critical and imaginative thinking, where geology, chemistry, biology, and environmental issues intersected at every level, ranging from Earth history (Earth's physical past and how that drove the evolution of life on this planet) to environmental impacts of mining, where ecosystem health remains intimately connected with industry operations. I had no idea at the time, but it turned out I had been training since high school to be a biogeochemist. I never shied away from learning about different scientific disciplines; this eventually gave me the tools to examine complex environmental processes through a versatile lens.

What are the responsibilities of your current role as a Research Scientist/Environmental Biogeochemist?

As a research scientist, I conduct both field and laboratory studies that are commonly multifaceted. This means I travel to mines across Canada to conduct targeted field sampling, and these samples are then taken back to the University of Toronto, where they undergo analysis. Data analysis and interpretation is constant, and I disseminate those findings through research article publications, international conferences presentations, etc. I am also deeply passionate and active in educational outreach programs, where I get to directly connect with students in elementary and high schools, encouraging those who are interested to enter STEM university or college programs.

Describe your typical work week.

A typical work week for me is never boring, as it can change from day to day or week to week depending on research activities underway. Some weeks I travel to do field work, others I spend in the laboratory doing analysis. It turns out that becoming a scientist inadvertently made me a writer, as I often address questions that the scientific community has not yet answered with "stories" that come out of our research. I constantly coordinate with our research team and mining partners, as everything we do is highly collaborative, and I get to work with an amazing team of bright, curious, and energetic individuals who, I believe, love this work as much as I do.



Field data collection

What do you like most about your job?

I fell in love with Earth science because the wonders of the natural environment amazed me, and that has never changed. If anything, I am more curious and amazed than ever. I love being outdoors and feel extremely fortunate to have a career that allows me to be there.

What education and training are required for your work?

Academically, research associates have a bachelor's degree and a PhD (and some get a MSc along the way). Generally, research training, both in the laboratory and field, occurs throughout school, depending on your specific research program. Learning and training never really cease though, and nor should they, as the scientific discipline is always evolving, and a good research scientist will do the same.

What are the skills and qualities that you consider important to succeed in the minerals industry broadly and in environmental biogeochemistry specifically?

Skills and qualities that I consider to be crucial to work within the minerals industry are a strong work ethic and the ability to be self-directed. This sector, with its many different avenues, has a long history of providing the global community with commodities that are needed daily, and it will be an important part of developing a sustainable future on this planet. Anyone with a creative mind and a love for science-based discovery, and who is ready to tackle complex environmental challenges would be well-positioned to succeed in this industry. Also, the industry is benefitting more every day as personnel diversity increases across the sector with regards to background, nationality, gender, race, sexual orientation, etc., since diverse backgrounds undoubtedly result in more innovation.

How has technology changed environmental management practices in the minerals industry?

The minerals industry has been confronted with unprecedented expectation from the global community. Minerals must be mined utilizing only best-sustainability practices. In an industry with operations that can dramatically change the landscape and impact local water quality and communities, innovative and rigorous environmental management practices have become part of the framework in Canada and abroad. These challenges are complex, and when not met with the best environmental management technology, can lead to serious impacts on local ecosystems. We have come a long way, but there is still a lot of work to do, and this is where industry and scientists working collaboratively is so crucial.

How do you see environmental biogeochemistry jobs changing in the future?

Interdisciplinary jobs, such as those in environmental biogeochemistry, will become more in demand as we address complex environmental issues. There is a growing awareness, even beyond the scientific community, that going forward, people who are trained to answer complex multifaceted scientific challenges will be crucial to a truly sustainable minerals industry.

What advice do you have for a student interested in learning more about or considering a career in environmental biogeochemistry?

Whether you are in elementary school, high school, or university, I suggest that you seek out opportunities that provide first-hand experience in the natural environment: perhaps a summer camp, a Mining Matters workshop, or a hike to the Scarborough Bluffs. Just get out there and see for yourself how wonderful this world is!

Also remember that sometimes, while a new subject may be daunting at first (admittedly, I was not thrilled by grade 11 chemistry), it all becomes familiar with time. And finding the right teacher or professor can make what seemed dull or too hard, exciting, and completely doable. I was the type who needed to know the "Why?" before I felt energized to discover the "What." Safe to say, I have now found my "Why?"

Was there an inspirational moment or educator in high school that helped set you on your path? If so, please describe the moment or educator.

There was a math teacher at my high school who taught enhanced mathematics, but as I recall, prior to that, he worked as a research scientist at NASA. He was obviously brilliant, but he could not have been more encouraging and wonderful to every student who walked into his classroom. It was the first time I had known someone personally with a PhD who worked at NASA (I now have biogeochemists friends there), and it made something that seemed unattainable suddenly a possibility. I cannot remember all the calculus he taught us, but I remember that.

Collecting water samples in the field.

Teaching students in the classroom

Elementary Student Activity: Rock Story Drama

BACKGROUND

Rocks are grouped into three main categories: igneous, metamorphic, and sedimentary. Each is categorized by the minerals it includes, its chemical composition, and its process of formation.

Igneous rock forms from the cooling and solidification of molten rock. Igneous rocks can be classified as intrusive or extrusive. Intrusive rocks, also referred to as plutonic, solidify slowly under the Earth's surface and include large, visible crystals. Granite is a common example. Extrusive rocks, also referred to as volcanic, solidify quickly at the Earth's surface, creating small crystals, sometimes visible only with the aid of a microscope! Rhyolite is a common example.

Metamorphic rocks result from the physical or chemical transformation (metamorphism) of existing rock due to heat and pressure. If heat and pressure are extremely high, some minerals may react chemically with each other and form new minerals. These changes are so extreme that the rock's original identity is obscured. Foliation (colour banding) is a physical characteristic of some metamorphic rocks where minerals line up due to pressure. Examples of metamorphic rocks include gneiss, slate, marble, and quartzite.

Sedimentary rocks, classified as clastic, biochemical, or chemical, are formed from particle deposits that accumulate on the Earth's surface. Clastic sedimentary rocks result from eroded Earth materials such as gravel, sand, silt, and clay-sized particles being transported by gravity, water, wind, or ice to where they are deposited. Over time, the sediments accumulate in layers, cementing together into rock. Examples are sandstone and shale. Biochemical sedimentary rocks are created when living creatures that use materials dissolved in air or water to make their tissues die and sink to the ocean floor. The sediment then gets compacted and cemented into solid rock. Examples are limestone and dolostone. Chemical sedimentary rocks form when minerals in solution precipitate. Examples are limestone and rocks composed of evaporite minerals, like gypsum and halite. Fossils are often found in sedimentary rocks.

Purpose

In this kinesthetic activity, students work in small groups to demonstrate their knowledge of the three rock groups. They create short scenes, incorporating movement, dialogue, and creative arts that show the formation and characteristics of one of the three rock groups. Students draw a picture to illustrate their knowledge.

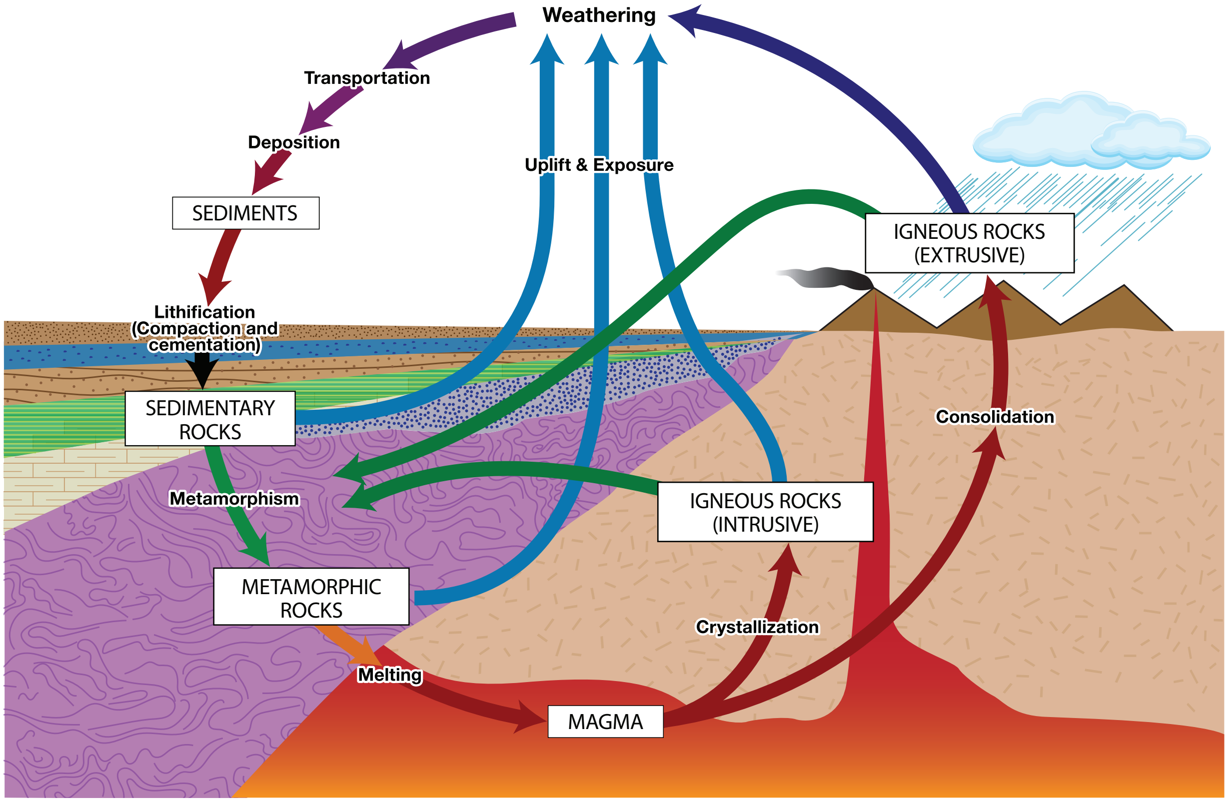
MATERIALS

- Copies of the **Rock Clues You Can Use** table
- Copies of the **Rock Cycle Diagram**
- Creative Materials (construction paper, scissors, glue, craft sticks, pipe cleaners)
- Props

INSTRUCTIONS

1. Discuss or review the three rock groups and the rock cycle.
2. Place students into small groups.
3. Ask each group to choose a rock group and create a short dramatic scene that shows the formation and characteristics of that rock group. Encourage them to use the **Rock Clues You Can Use** table and the **Rock Cycle Diagram** to help them to review their rock group's characteristics and qualities and how they are formed.
4. Ask each group to prepare a plan to incorporate movement, dialogue, and props into their scene.
5. Using a sheet of paper ask each group to create a drawing that illustrates their knowledge about their rock group.
6. Allow students 15 minutes to create any props that they plan to incorporate into their scene.
7. Conclude with a group self assessment, asking students to name their group members, describe their task, and say what they did well and what they could have done to improve their performance.

ROCK CYCLE DIAGRAM



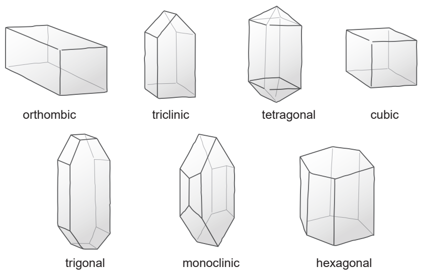
ROCK CLUES YOU CAN USE

Igneous Rock	Metamorphic Rock	Sedimentary Rock
• Formed from magma, a molten material that exists beneath the surface of the Earth • Magma can erupt or flow onto the surface of the Earth as lava that cools and solidifies quickly to form volcanic igneous rocks • Volcanic igneous rocks cool quickly and might not contain mineral grains that are visible to the naked eye • Magma can cool and solidify beneath the Earth's surface, creating plutonic igneous rock • Plutonic igneous rocks have visible crystals or grains because they cool slowly inside the Earth • Examples include granite, gabbro, basalt, and andesite	• Formed when rocks are changed by heat and pressure either deep within the Earth or through contact with igneous rocks • These changes are so extreme that the rock's original identity is obscured • If heat and pressure are extremely high, some minerals may react chemically with each other and form new minerals • Foliation (colour banding) is a physical characteristic of some metamorphic rocks where minerals line up due to pressure • Examples include gneiss, slate, and marble	• Formed from rock particles called sediments that are created by weathering (erosion) • Particles are eroded (picked up, moved, and deposited) by wind, water, glacial ice, or gravity moving them down a slope • Particles settle onto the land and into bodies of water • Over time, particles become compacted, layer upon layer, and cemented together to form rocks • Fossils are found in sedimentary rocks • Examples include sandstone, shale, limestone, and dolostone

Secondary Student Activity: Evaporite Crystal Growth Experiments

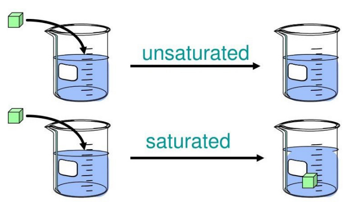
BACKGROUND

Crystallography is the study of the formation, structure, and properties of crystals. The structure of a crystal is defined by a unique repeating arrangement of atoms. There are seven crystal systems: cubic, tetragonal, triclinic, orthorhombic, hexagonal, monoclinic, and trigonal.



Mineral crystals can form from solutions. They tend to form into shapes consistent with their crystal system when they have time and space to grow. How fast crystals grow depends on the temperature of the solvent, such as water, into which the solute (the mineral) is dissolved, the concentration of the mineral in solution, humidity, and other factors. But it all starts with a nucleation point: the first building block that gets the ball rolling. This could be anything from a surface crevice or rough patch to an existing crystal.

There are three types of solutions: unsaturated, saturated, and supersaturated. An unsaturated solution contains less dissolved substance than a saturated solution. In the diagram to the right, in the unsaturated solution, we see that the solute (salt) dissolves completely in the solvent (water). A solution is saturated when the solvent contains as much of a dissolved substance as it can hold. In some situations, a solution may become supersaturated, where it can hold more dissolved substance than should be possible. Such a solution is unstable and will return to a saturated state with minor disruptions, like changes in temperature.



The rate at which a crystal grows affects the resulting crystal. A crystal that grows quickly will likely be flawed and have impurities, while a crystal that grows slowly will likely have few flaws and impurities. The number of crystals grown from a solution depends on the number of nucleation points that are present. Many nucleation points will commonly result in small crystals, while few nucleation points will result in larger crystals.

Halite Crystal—Cubic System

PURPOSE

Evaporite minerals form in nature from the evaporation of salt or fresh water. In this activity, students will grow cubic crystals of the common evaporate mineral halite (NaCl, table salt) and observe and record how the crystals form as they grow. You are encouraged to experiment with different types of halite (rock salt, sea salt) and with other mineral solutions to compare and contrast their crystal shapes. Other evaporate minerals of interest include magnesium sulfate, $MgSO_4$ (Epsom salts), sodium tetraborate, $Na_2[B_4O_5(OH)_4]\cdot 8H_2O$ (Borax), and alum, $KAl(SO_4)_2\cdot 12H_2O$ (potassium aluminum sulfate). Crystals grown from each of these mineral solutions may display different shapes, but all the crystals grown from a particular mineral solution will have the same structure.

MATERIALS

- Water (distilled, if possible)
- Small cooking pot
- Hot plate/stove
- Halite (salt) (optional: other minerals)
- Scissors
- One or two beakers or shallow dishes, for each group
- Food colouring (optional)
- Construction paper (dark colours)
- Lined paper or a booklet (to record observations)

Rough Diamond

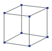
PROCEDURE

Safety ⚠

Exercise caution when using the stove or hot plate and when handling the hot solutions. Be careful when using scissors and food colouring as it can stain hands/clothing/containers. Do not ingest the solutions.

1. Divide the students into small groups.
2. Ask that each group cut construction paper to fit in the bottom of their beakers or dishes.
3. Have students place the paper in the bottom of each of their beakers or dishes and label them with the name of the mineral solution and record any other important details.
4. Fill the cooking pot approximately halfway with water.
5. Set the cooking pot on the hot plate or stove and bring the water to a boil.
6. Measure a quantity of salt and gradually add salt to the boiling water.
7. Continue to add salt until the solution is "saturated" (i.e., no more salt will dissolve).
8. Record the quantity of salt.
9. Add a drop of food colouring to the solution, if desired.
10. Carefully pour a small amount of the solution into one of each group's beakers or dishes. The solution should be no more that a few millimetres in depth.
11. Set the beakers or dishes aside where they will be undisturbed for several days.
12. Repeat steps 6 to 11 for any of the other mineral solutions.
13. The experiment is concluded when the solutions have evaporated.
14. Ask students to create an observation table to record the results of their experiment. Ask that they record information such as the mineral that was used to create the solution, the number of days that it took for crystals to form, the shape of the crystals that formed, and anything else that they consider important.
15. Ask students to photograph their experimental setup, make daily observations of crystal growth over time, and record them in their observation tables.

Sample mineral solution experiment observation table

Solution	Day	Crystals	Notes/Sketch
Halite	1	No	- day 1 of experiment - completed the set up - no crystals are present in the solution
Halite	2	No	no crystals are present in the solution
Halite	3	Yes	cubic crystals have formed on the paper 
Halite	4	Yes	crystals have formed on the paper and in the beaker
Halite	5	Yes	the solution has completely evaporated
Halite	6		

To conclude the experiment, review the students' observation tables and discuss their results, using the questions below.

1. How long did it take for crystals to form? Were the rates of crystal formation different for the different solutions?
2. What shapes are the crystals? Are they different for each of the mineral solutions?
3. How did adding food colouring to the solution affect the crystals?
4. Do you think the method you used in your experiment is similar to how halite, or other evaporite minerals, actually form on Earth? Do some research to compare and contrast.

Borax crystals

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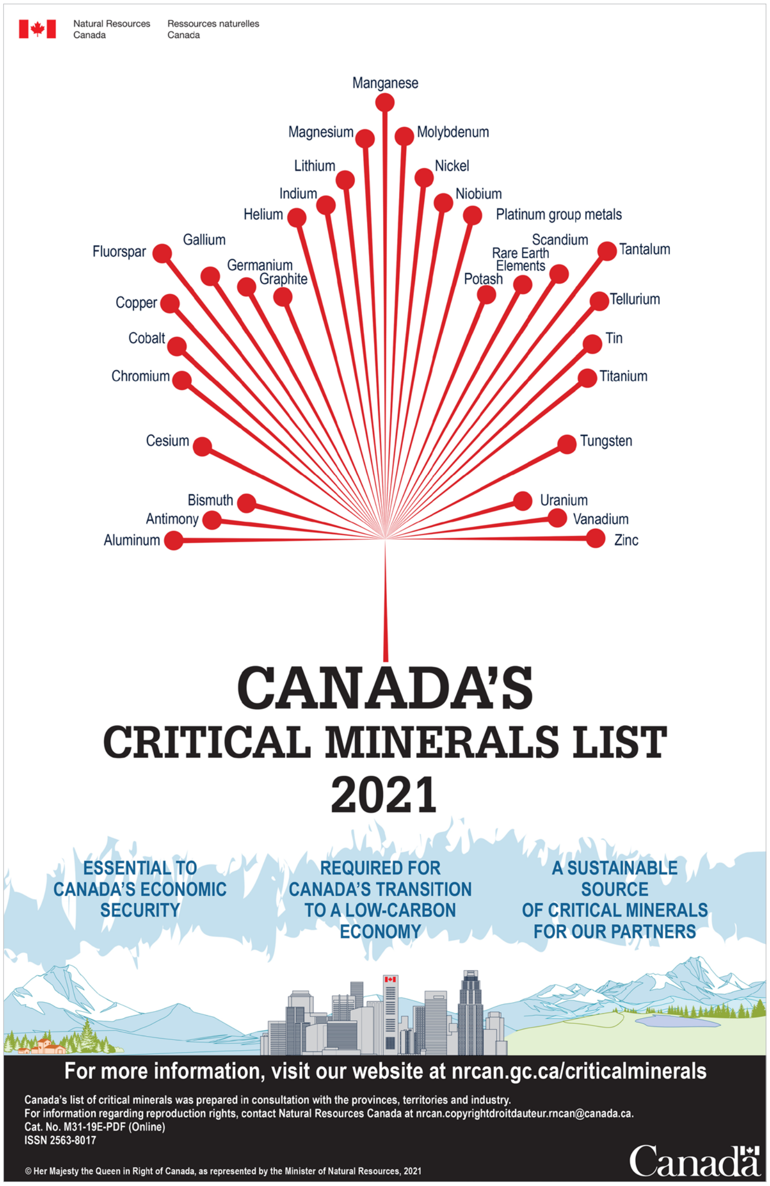

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