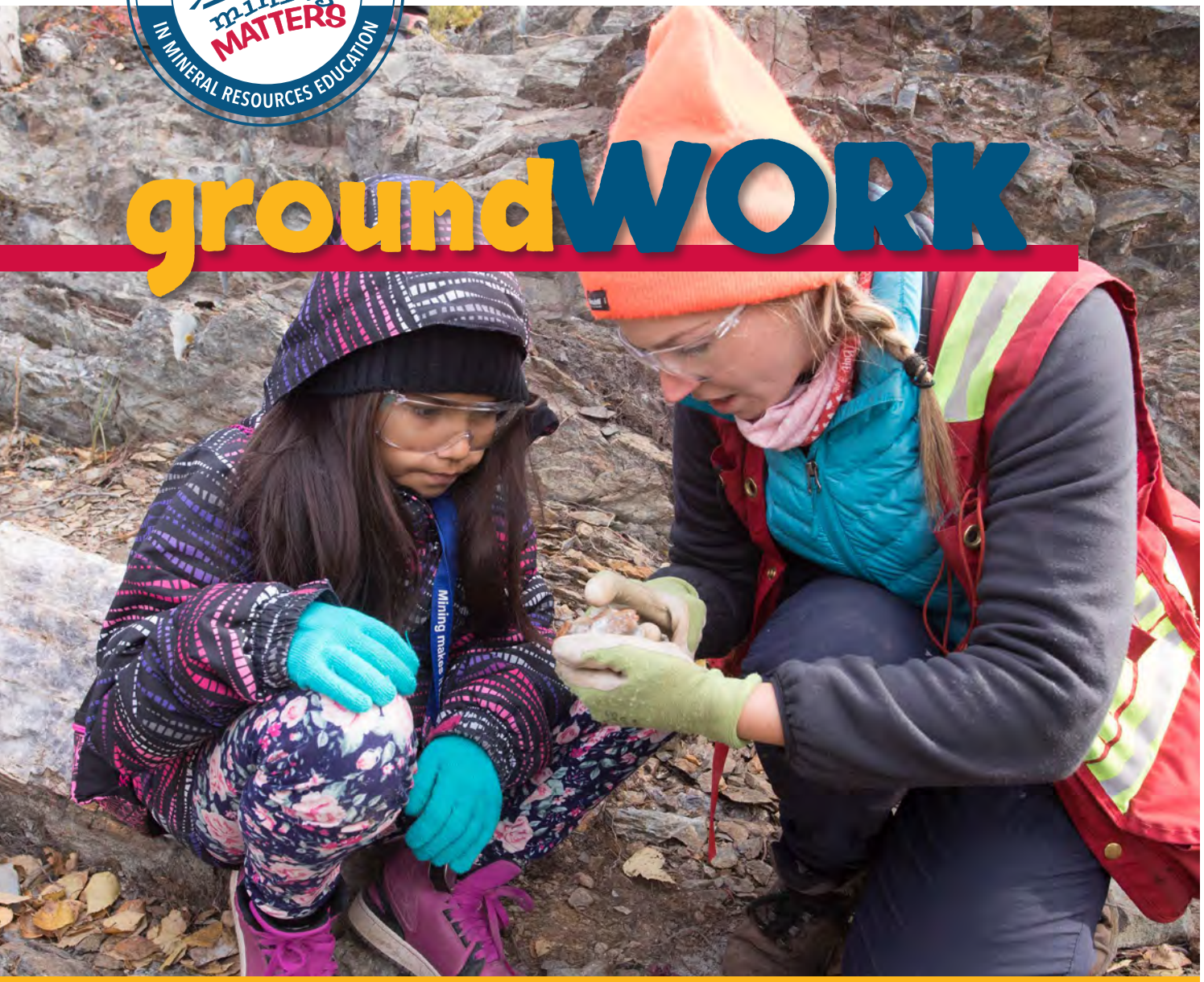
2019

groundWORK



Supporting teachers with classroom resources and training in mineral resources education since 1994.

Contents

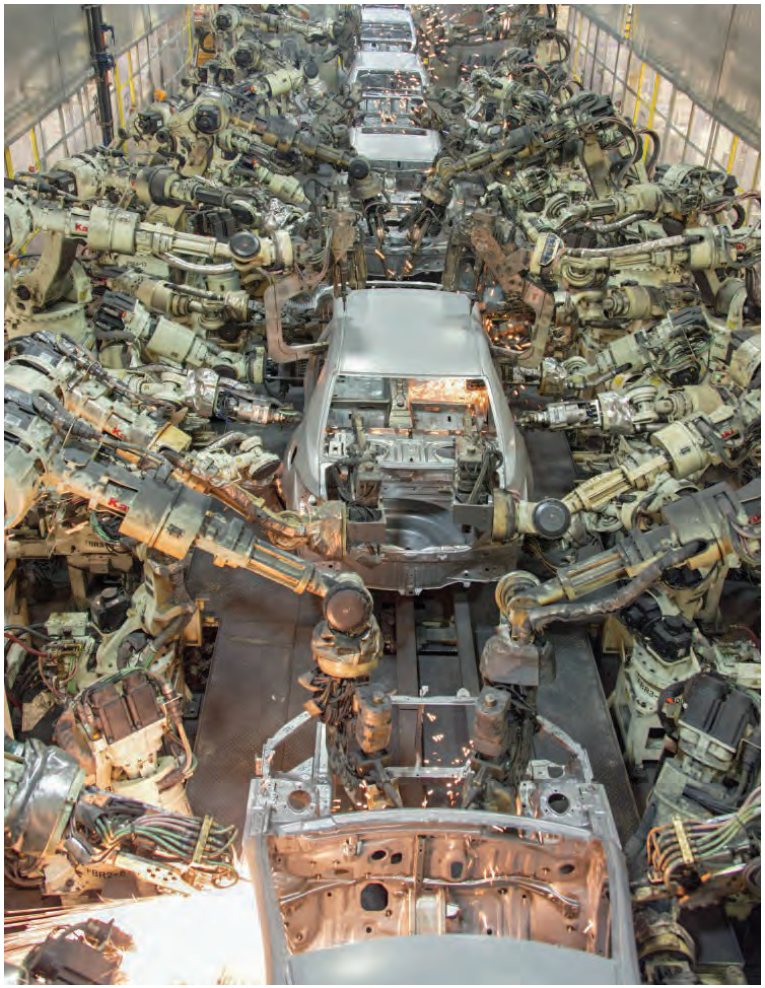
ROBOTICS

Robots are everywhere! Perhaps not the robots of movie fame, lovable ones like R2D2 and humanoid C3PO or scheming machines that take over from their human masters, but multitudes that perform countless tasks around the world. The word "robot" was originated by playwright Karel Capek from the Slavonic word "robota," meaning servitude or forced labor. The term "robotics" originated in 1941, when author Isaac Asimov used it in his science fiction writing. Today, robotics technology has altered the world of work, serving humanity in many ways.

Robot Uses

Today, robotics is a field of technology dealing with the design, construction, and operation of robots in an endless array of applications. Many uses exist, and many are in development, but a few examples in operation include

- industrial robots (welding, milling, sculpting, spray painting, material handling, packaging, assembly)
- aerospace robots (Canadarm, Mars exploration Rovers, robotic spacecraft, satellites)
- medical robots (drug delivery, precision surgery, patient handling, rehabilitation therapy, decontamination of healthcare spaces)
- military robots (transport, search and rescue, combat)
- agricultural robots (seed planting, harvesting, environmental monitoring, analyzing soil)
- mining robots (mineral exploration, drilling, transporting ore)
- underwater robots (data collection, underwater mining)



Car assembly at a Toyota Canada plant

Inside Robotics

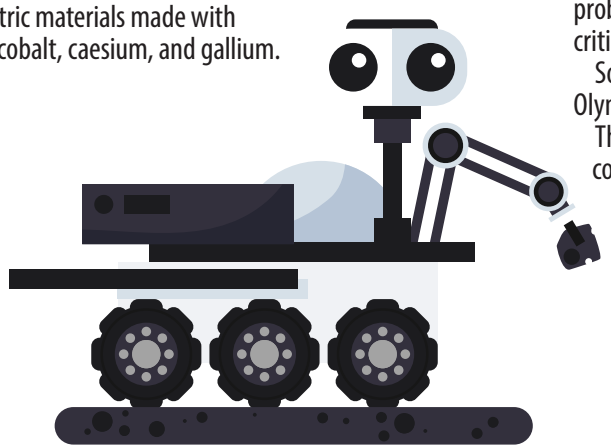
What goes into a robot or a robotic application? There are three main components: a controller, mechanical parts, and sensors. The controller, or "brain," run by a computer program, dictates actions such as movements and reactions. The mechanical parts, or body, work together to make it turn, move, grab, and lift things, usually powered by electricity. Those parts include grippers, gears, wheels, motors, and pistons. For applications that interact with their surroundings, sensors determine such things as different sizes and shapes, space between objects, distance travelled, the amount of pressure required to grasp things, and more.

What do all these parts of robotic applications have in common? Quite simply, each one uses metals and minerals from the Earth.

Computers and electronic devices used to control the application contain circuit boards, semiconductors, and other components. These contain many elements, such as copper, silver, gold, palladium, platinum, tantalum, tin, lead, tungsten, silicon, germanium, nickel, indium, niobium, neodymium, cobalt, and more. Controllers would be in steel electrical cabinets near the robot work area or on the robot itself.

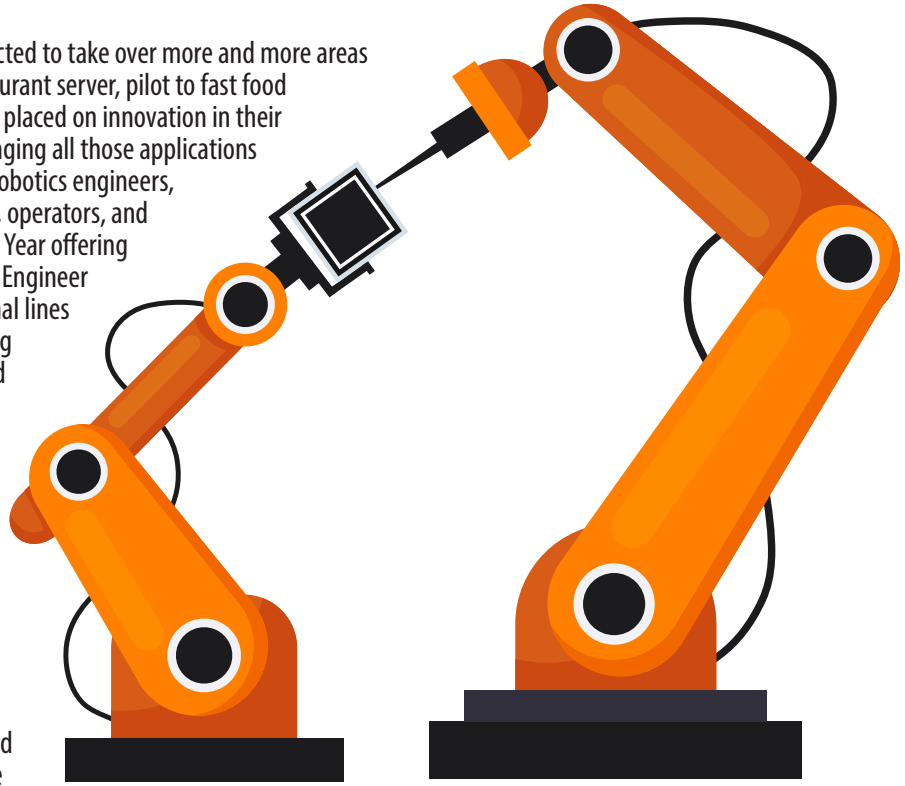
The body would include cladding and many mechanical parts–an industrial robot can contain 2,000 individual parts–including electric motors, hydraulic cylinders, bearings, wiring, hoses, tractor treads or wheels, and more. Steel, cast iron, and aluminum are often used for the arms and bases of robots. High-tech applications such as space or medical uses might use carbon composite and titanium. Other mechanical parts could include various types of steel such as stainless, surgical, or carbon steel; aluminum; silicone; rubber, and more.

A multitude of sensors can be found in robotic applications, including those for light, sound, temperature, moisture, proximity, and pressure. Sensor types include laser, infrared, ultrasonic, magnetic, GPS, and more. One type of light sensor, Lidar (Light Detection and Ranging), includes a laser transmitter, a photodetector or photodiode receiver, and a processing component. Lasers comprise rare earth components such dysprosium, yttrium, and neodymium. Materials commonly used for photodiodes include silicon, germanium, and indium gallium arsenide. To process the sensor input, silicon is one of the most important semiconductors. Infrared sensors often use artificial pyroelectric materials made with lithium, cobalt, caesium, and gallium.



Careers in Robotics

With robotics and automation expected to take over more and more areas of labour, from farm worker to restaurant server, pilot to fast food worker, increased emphasis is being placed on innovation in their development. Developing and managing all those applications takes trained professionals such as robotics engineers, software programmers, technicians, operators, and more. In fact, the 2018 Career of the Year offering from toymaker Mattel was Robotics Engineer Barbie®, coming with the promotional lines "Dream big! Kids can explore exciting opportunities in the high-tech world and code their own futures!



Robotics for Kids

For kids interested in robotics, there are lots of options to learn and have fun. Robotics clubs and camps across the country help kids develop their interest, skills, and knowledge of related technology. At camps, working in small teams, students use design systems to compete in fun real-world challenges like robo-soccer, obstacle courses, capture-the-flag, tag, maze solving, and more. For a comprehensive list of camps, go to ourkids.net/robotics-camps.php

Also, many Canadian universities offer STEM camps for kids, featuring robotics. Participants work in teams to solve problems as well as create their own designs and inventions, learning skills in communication, leadership, design, and critical thinking.

Some courses offer preparation for international competitions like FIRST Lego League (FLL) and World Robot Olympiad (WRO) in different categories.

The FLL releases an annual Challenge, based on a real-world scientific topic. Teams of up to 10 children, with adult coaches, program an autonomous robot, developing a solution to the problem. firstlegoleague.org/

WRO holds tournaments around the world, with the international final in November hosted by a different country each year. Teams of two or three students and a coach can participate in four different categories with different age groups, from very young to university age. Participating teams design, build, and program a robot model that can meet a challenge, play soccer, or demonstrate a solution for a real-life problem. wro-association.org/home/

WHERE challenge

Sponsored by Teck

Encourage your students to take the WHERE Challenge this fall and discover what on Earth is in their stuff!

Mining Matters WHERE Challenge is back for its 11th year! The national contest, endorsed by the Canadian Earth Sciences Community, challenges students between the ages of 9 and 14 to demonstrate their knowledge of Earth's non-renewable resources in a creative fashion, whether it be through literature, media, or graphic design, while competing for $10,000 in cash prizes. Students are motivated to explore the fields in which geoscientists work: **W**ater, **H**azards, **E**nergy, **R**esources, and the **E**nvironment and answer the questions, "What on Earth is in your stuff?" and "WHERE on Earth does it come from?" The WHERE Challenge encourages students to discover the importance of non-renewable resources by relating them to objects used in everyday life, from the use of zinc in batteries and petroleum in building blocks, to nickel in figure skates and gold in computers.

Entries, in English and French, can be submitted online at earthsciencescanada.com/where/ where you can view past winning entries. Contest closes March 7, 2019.

Please visit the WHERE Challenge website for a comprehensive list of 2018 winners: earthsciencescanada.com/where/2018_results.html

Encourage your students to brainstorm for ideas that will blow judges away in the 2018–2019 contest!

We are offering a limited number of free hands-on workshops to schools committed to participating in the challenge.

Contact WHEREChallenge@miningmatters.ca for more information.

Water Hazards Energy Resources Environment

Rocks + Kids = Opportunities

Mining Matters continues to target underserved schools in the Greater Toronto Area with its curriculum-linked program, *Rocks + Kids = Opportunities*. The R+K=O Program offers education workshops for students in grades 4 and 5, at no cost to schools, and includes a set of teacher resources and student handouts. Teachers can customize their workshops by selecting several themes from a set of 14 Earth science and mineral resource activities. **Mining Matters** is pleased to have struck a formal partnership with the Toronto District School Board to extend the program into 15 of their schools. In the 2017–2018 school year, 43 workshops were delivered to 1029 students. To learn more about *Rocks + Kids = Opportunities* or to request a workshop, contact schoolprograms@miningmatters.ca.

Mining Matters Resources

New Poster: Music from the Earth

Mining Matters has a new addition to its "Mining Makes it Happen" original poster series, which highlights the importance of minerals in our everyday lives. Our fifth poster, *Music from the Earth*, explores the connection between music and the minerals, metals, and elements of the Earth. It looks at what goes into familiar and world instruments and into some of the devices–from gramophones to smartphones–that have brought music to our ears over the last century. See this poster and other original posters in our MMIH series at tinyurl.com/mmresources-MMIH-posters

Resource Kits

Looking for Earth science learning opportunities to bring Earth science to life for your students? **Mining Matters** teaching resources for classrooms, developed by teachers for teachers, meet provincial Earth science and Geography curriculum mandates and guidelines. Three resource kits are available:

- ✓Junior/Elementary: Deeper and Deeper: Discovering Rocks and Minerals
- ✓Intermediate/Middle: The Earth's Crust (Manitoba only)
- ✓Senior/Secondary: Discovering Diamonds

Resource kits are available in English or French through a prerequisite in-service workshop. Workshops can be arranged for between 10 and 24 teachers, anywhere in Canada, with four weeks prior notice.

PDAC March 3-6 2019 SAVE the Date

The Prospectors and Developers Association of Canada is the world's leading convention for people, companies, and organizations connected with mineral exploration. The four-day convention, held annually at the Metro Toronto Convention Centre, occurs this year March 3–6, 2019.

Educators are invited to attend **Mining Matters** Teachers' Day on Sunday, March 3, 2019. Teachers may register for an all-access pass to the Convention Trade Show, where they will see exhibits promoting the latest technology, products, services, and global mining jurisdictions. Preregistration with **Mining Matters** is required for this unique professional development opportunity. Contact schoolprograms@miningmatters.ca.

And More...

Mining Matters Core Concepts are stand-alone classroom-ready activities that reflect key foundational ideas in Earth science.

Mining Matters Activity Book for youth ages 9 to 13 years is packed with puzzles, including codes to crack, things to spot, word searches, crosswords, Sudoku, and more. Available in English, French, and Spanish, it encourages kids to learn about rocks, minerals, metals, mining, and minerals industry careers.

Mining Matters, with the Ontario Ministry of Northern Development and Mines, created the **Rocks of Ontario Guide** and the **Fossils of Ontario Guide**. The first features rocks commonly found in Ontario and the processes that shaped them. The second features fossils commonly found in Ontario and how life, even millions of years old, has been preserved.

Mining Matters "What is a Mine?" colouring book features Mighty Miner, who guides students through an adventure that helps them learn about mining.

Learn more about these resources and how to get them at miningmatters.ca/resources/education/mining-matters-publications/

Our $500 **Mining Matters** Field Trip Subsidy was used toward a field trip to the Stonewall Quarry Heritage Arts Centre, where 64 grade 7 and 8 students were able to participate in an experiential learning program that focused on limestone fieldwork and fossil hunting. Elmwood High School is located in a socioeconomically challenged community and the subsidy was critical to offsetting costs for families.

Jenna Forslund, Elmwood High School, Winnipeg, Manitoba

Field Trip Subsidies

Available to teachers across Canada, our annual Field Trip Subsidy Program provides support for enriched Earth science learning. Subsidies serve to offset some of the costs associated with transportation and entrance fees to geoscience venues and to stone, sand, and gravel operations, as well as excursions involving Earth materials, processing, and manufacturing. **Mining Matters** encourages active outdoor field exploration, such as rock walks and visits to quarries and rehabilitated mine sites, as well as indoor excursions to museums and science centres to experience and reinforce geoscience concepts. All applications are considered on a first-come, first-served basis. For complete details, visit miningmatters.ca, and enter Subsidy Application Procedures in the Search box.

Field Trip Ideas

Newfoundland and Labrador Geology

Newfoundland and Labrador are home to some of the oldest rocks and fossils on the planet.

- Get to know the volcanoes, earthquakes, and natural forces that shaped our world at the **Johnson GEO CENTRE** in St. John's. geocentre.ca/
- Tour the historic mine on **Bell Island**, not far from St. John's, where men and boys as young as 12 dug out almost 80 million tonnes of iron ore between 1895 and 1966. bellislandminetour.com/
- Visit **Manuels River Hibernia Interpretation Centre** in Conception Bay South to learn about ancient volcanoes, beaches, and glaciers, and discover an extinct marine arthropod that made this area famous. manuelsriver.ca

For more ideas, visit newfoundlandlabrador.com/things-to-do/geology-and-fossils

The Mineralogical Museum of Abitibi-Témiscamingue, located in Malartic, Quebec, presents an exhibition on geology and mining projects in the region, as well as minerals from around the world. Interactive games, an earthquake simulator, fairy stones, moon rock, and gold samples complete this exhibition. Also, discover the facets of rare earths and experience the world of fluorescent minerals. reseaumuseal-at.ca/item/musee-mineralogique/

Ontario's Highlands: Hidden Gems

Experience recreational geology in Ontario's Highlands. Take a look at *Hidden Gems*, a comprehensive brochure that features interesting places to look for "buried treasure" and learn about the area's geoheritage and industrial heritage, the power of water, and full-service recreational geology attractions and ready-made experiences. Check out interesting destinations in Haliburton Highlands, Hastings County, Frontenac County, Lanark County, Lennox and Addington, and the Ottawa Valley. highlandseast.ca/files/2014_geology_brochure.pdf

Stones 'n Bones Museum

In Sarnia, Ontario, the Stones 'N Bones Museum offers an extensive and diverse collection of world-class items, with over 6,000 objects displayed in a 10,000 sq. ft. space, including dinosaurs, minerals and fluorescent minerals, fossils and artifacts, gemstones, crustaceans and shells, and more. stonesnbones.ca/

The Cobalt Mining Museum and the Colonial Adit

The Cobalt Mining Museum, in Cobalt, Ontario, strives to preserve much of Cobalt's past and boasts the world's largest display of native silver ore, along with artifacts and photographs dating back to the early days of the silver rush. Also displayed are various mineral samples that, when viewed under black light, present a rich array of colours. cobalt.ca/visitors/museums/

Experience early silver mining in the Colonial Mine, which produced 1.25 million ounces of silver between 1907 and 1937. Interpretive guided tours of this site are available through the Cobalt Mining Museum. cobalt.ca/visitors/tours/

Institute of Robotics & Intelligent Systems

The Toronto-area Institute of Robotics & Intelligent Systems (IRIS) offers field trips for classes, providing full-day hands-on STEAM (Science, Technology, Engineering, Art, and Mathematics) based workshops where students can explore multiple programs. IRIS also delivers STEM-based educational programs, geared to different grade levels, to the classroom. iriscanada.com/

The Manitoba Museum

The Manitoba Museum has long been a centre for collections and knowledge related to the Earth and the history of life. Significant collections include Manitoba minerals, fossils from the Ordovician Period (445–450 million years old), marine fossils from the Cretaceous Period (70–100 million years old), and ice-age mammals. manitobamuseum.ca/main/collections-research/manitoba-nature/geology-paleontology/

Museum of Natural Sciences

In Saskatoon, Saskatchewan, the Museum of Natural Sciences is designed to outline evolution throughout geological time, providing an integrated learning environment, with displays of living plants, animals, fossils, rocks, and minerals. A working seismograph is on display. The museum also serves as a teaching resource for university and school students and visitors. artsandscience.usask.ca/museumofnaturalsciences/

Royal Saskatchewan Museum

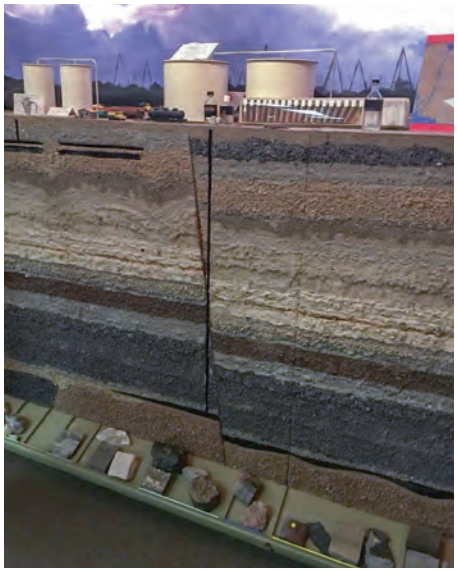
With two locations, the Royal Saskatchewan Museum (RSM) gives students in Regina and Eastend, Saskatchewan, double the opportunity to explore the world of paleontology. The Regina Museum offers Discovering Dinosaurs, for grades 1 to 4. Using replicas and real fossils, students explore what fossils are, some of the dinosaur fossils found in the province, and the work of RSM paleontologists. A visit to the Earth Sciences Gallery is included in the program.

In Eastend, the T. rex Discovery Centre features Scotty, the most massive T rex skeleton in the world. Originally discovered in Saskatchewan's Frenchman River Valley in 1991, it took over 20 years to remove the rock attached to the fossilized bones. A perfect copy of the bones was cast and was unveiled in Eastend in 2015. A second full-sized Scotty will be on display in 2019 in Regina. The Discovery Centre also features five school programs for various grade levels: Discovering Dinosaurs; What Big Teeth You Have; Fossil Finders; Rocks: My World; and Bone Bed Dig Pit. royalsaskmuseum.ca/

Pacific Museum of Earth

Located in the Department of Earth, Ocean, and Atmospheric Science at the University of British Columbia (UBC), in Vancouver, the Pacific Museum of Earth invites visitors to explore the wonders of planet Earth. The newest permanent exhibit, Canada's first OmniGlobe, is a spherical interactive display that projects images and animations of planets, real-time weather, ocean currents, tsunami wave height data, forest fires, ancient ice coverage, and plate tectonics. The museum also features a Mineral and Gem collection, an Evolution of Earth display, a Rock Hall that explores Earth's rock cycle, a tornado machine in Weather Alley, and more. Take a virtual tour of the museum from your home. pme.ubc.ca

Mineral Resources and Mining Education Tour - Lac des Iles Mine



OIL MUSEUM OF CANADA

You might be surprised to learn that North America's first commercial oil well was established in Canada, in 1858, prior to Confederation. Perhaps more surprising is that it was not located in Western Canada, but in Ontario. Designated a National Historic Site, the well is no longer in production but remains on site at the Oil Museum of Canada, in the Village of Oil Springs, in what remains to this day, an active oilfield. The museum serves the important role of chronicling the history of this important oilfield that ultimately launched the modern petroleum industry.

The museum includes both indoor and outdoor exhibits. Inside, an installation describes the geology and stratigraphy of the region and displays artifacts that highlight the technology that was developed to access and process the petroleum. Outdoors are original oil well workings and extractive and processing equipment. Visitors can take the Oil Heritage District Driving Tour to see many local oil history highlights, each accompanied by a radio description.

The Oil Museum offers an education program to students that complements history, geography, and science curricula. **Mining Matters** will be partnering with the museum to provide professional learning workshops for teachers and public education. lambtonmuseums.ca/oil/

Mineral Resources and Mining Education Tours
Unique Professional Development Opportunities 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 the Mineral Resources and Mining Education Tours, an innovative and fully sponsored professional learning program for educators. Typically, the tours are delivered in August but have also been offered as Conference field trips, during the academic year.

The 2019 program will include a "Mine Life Cycle Tour" that will provide teachers with an opportunity to learn about all of the phases of the mine life cycle. The tour will include visits to an underground nickel mine and reclamation sites in Sudbury, engaging with industry professionals, and Earth science and mineral resource instructional development workshops. The "Life in a Mining Camp Tour" will feature an overnight site visit to North American Palladium's Lac des Iles Mine and visits to geological and mining sites of interest in and around Thunder Bay.

Visit the Canadian Ecology Centre website for details and to complete your registration. canadianecology.ca/professional-development/miningtour/

DID YOU KNOW?

A long-lost chunk of Canada has been found in Australia, according to geologists who analyzed ancient sedimentary rocks in Georgetown, Queensland, and found clues about where those rocks were when they formed. The data suggests that the Georgetown rocks broke off from Canada and collided with northern Australia around 1.6 billion years ago, during the formation of the supercontinent Nuna. cbc.ca/news/technology/canada-australia-nuna-supercontinent-1.4508780

The oxygenation of Earth's atmosphere was thanks, in part, to iron and silica particles in ancient seawater, according to a new study by geomicrobiologists at the University of Alberta. But these results solve only part of this ancient mystery. sciencedaily.com/releases/2018/08/180807103659.htm

Geologists have uncovered new clues about the largest mass extinction ever in the history of the Earth, known as the End-Permian Extinction, or the Great Dying. The event occurred around 250 million years ago when a massive volcanic eruption in what is today the Russian province of Siberia sent nearly 90 per cent of all life into extinction. sciencedaily.com/releases/2018/08/180827121348.htm

Spectacular diamonds aren't always colourless, even though colourless stones predominate in today's jewellery market. Take a look at some spectacular stones that are anything but colourless. geology.com/diamond/spectacular-diamonds/

Volcanic eruptions can be detected in remote locations with the International Monitoring System, built to detect any nuclear explosion on Earth—underground, underwater, or in the atmosphere. The system includes a network to detect atmospheric infrasound, sound waves with frequencies below the lower limit of human audibility. sciencedaily.com/releases/2018/03/180329190852.htm

Saskatchewan is recognized as the world's #1 jurisdiction for attracting mineral investment according to the annual Fraser Institute Survey of Mining Companies. "Saskatchewan provides a low-risk environment because of both the great geological framework, and also the considered regulatory and policy frameworks. SMA member companies have made multibillion-dollar investments in Saskatchewan over the past decade. And because of these investments, mining remains a key pillar of Saskatchewan's economy in these transformational times," said Jessica Theriault, Chair of Saskatchewan Mining Association. tinyurl.com/saskmin

Canada ranks as third most valuable diamond producer in the world, according to Gary Vivian, President of the NWT & Nunavut Chamber of Mines. In 2018, the Ekati diamond mine in Northwest Territories, the first diamond mine to have opened in Canada, celebrated 20 years of diamond mining. miningnorth.com/chamber-news/101699

What has been called **a "once-in-a-lifetime" gold discovery** was announced in September 2018 by Canadian mining firm RNC Minerals. At the company's Beta Hunt mine in Australia, approximately 9,250 ounces of high-grade gold was produced from a 44 cubic metre area. The find includes two specimens which could rank among the largest ever discovered, 95 kg and 65 kg, holding estimated contents of 2,440 ounces and 1,620 ounces, respectively. The discovery is expected to yield approximately $C15 million. tinyurl.com/rncdiscovery

Let's Talk Science

Seventy percent of tomorrow's jobs will require science, technology, engineering, and math (STEM). Canada 2067 is a national discussion to help shape the future of STEM learning to make sure Canadian kids are ready. Try these hands-on activities designed to engage children of all ages in STEM experiences. letstalkscience.ca/Resources/Activities-Try-These

Let's Talk Science Outreach is a national, community-based program connecting educators and youth with outstanding volunteers to deliver a wide variety of meaningful science, technology, engineering, and math (STEM) activities for children, from preschool to Grade 12.

The Let's Talk Science Challenge is a team-based competitive enrichment event offered for Grades 6 to 8 students by Let's Talk Science Outreach volunteers across Canada. Students get the opportunity to build their team skills, interact with relevant role models, and test their abilities against peers. letstalkscience.ca/

Royal Ontario Museum App

The ROM has unveiled a new multiplayer, interactive, mining-themed game: ROMining. In the game, players assume different mining company roles and respond to genuine situations in an effort to maintain a balance between productivity and responsibility (modern mining).

Gamers explore real world issues like extending the life of a mine, community relations, health and safety, human resources, government regulations, and consumer consumption. The game is aimed toward students in Grades 4 to 12 and ages 8+. The ROMining app complements the Teck Suite of Galleries games table, on the museum's second floor. Gamers can use the app in the gallery or play on their own outside of the museum. rom.on.ca/en/learn/activities/games/romining

Top 10 Universities in Canada for Geology

For students interested in getting a post-secondary degree in geology, here is a list of the top 10 universities in Canada for a geology program, ranked in 2016 by universitiesrankings.com and *McLean's* magazine, both based on data from academic publishing company Elsevier plus their own surveys conducted by academics.

1. University of British Columbia, Vancouver, BC
2. Queen's University, Kingston, ON
3. University of Alberta, Edmonton, AB
4. Dalhousie University, Halifax, NS
5. McGill University, Montreal, QC
6. University of Calgary, Calgary, AB
7. University of Toronto, Toronto, ON
8. University of Victoria, Victoria, BC
9. University of Ottawa, Ottawa, ON
10. Western University, London, ON

macleans.ca/education/top-10-geology-universities/universitiesrankings.com/sciences/geology/top-10-universities-canada-geology.htm

Metals in an iPhone

Apple launched the first iPhone in 2007, and its best-selling units set the standard for smartphone performance and features. The iPhone would not be possible without the raw materials inside the case.
mining.com/web/infographic-the-extraordinary-metals-in-an-iphone-6s/

Apple has a new disassembly robot, Daisy, the most innovative and efficient way to reclaim more of the valuable materials in an iPhone. Daisy can take apart up to 200 iPhone devices per hour, removing and sorting components, so the company can recover materials that traditional recyclers can't—and at a higher quality. Check out Apple's environmental report at apple.com/ca/environment/

Inside Education

Inside Education looks at mining in Alberta. This four-part poster series examines Alberta's mining industry, the extraction process, natural resources hidden deep underground, the environmental and societal impacts, careers, and more. The front of each poster is a stunning visual related to the topic, while the reverse of each poster goes into further detail.
insideeducation.ca/learning-resources/elementary-school/#mining-poster-series

Essential Energy Everyday

Global energy demand is expected to increase by 30 per cent between 2018 and 2040. Lead batteries are part of the robust mix of renewable energy storage technologies required to meet that demand. Learn about how lead batteries have changed over the years, how they are sustainable, innovative, essential, and safe.
essentialenergyeveryday.com/

Metals on a Daily Basis

The Québec Mining Association offers a series of simple posters, in French, showing some of the metals used in everyday items, such as make-up, glasses, cellphones, bicycles, and more. amq-inc.com/lindustrie-miniere/les-metaux-au-quotidien

OneGeology

OneGeology is an international initiative of the geological surveys of the world who are working together with the support of international organizations, regional organizations, and industry sponsors to improve World Wide Web accessibility (including interoperability) and usefulness of global geoscience data needed to address societal issues, including mitigation of hazards, meeting resource requirements, and climate change. OneGeology Kids offers a fun introduction to geology for young children, letting them investigate what geology is all about, from dinosaurs and volcanoes to water and energy. onegeology.org/extra/kids/home.html

Britannica Kids

Britannica Kids is a premium resource that nourishes the desire for knowledge and the adventurous spirit in everyone! With nearly 250 years of experience in creating dependable content, Britannica offers a safe and trusted library of 100,000+ articles and 60,000+ media assets that is regularly refreshed with up-to-date information. Membership required. kids.britannica.com/

National Geographic

Canadian educators are invited to access free Education Resources on the National Geographic website for numerous subjects, including General Science, Earth Science, Geology, Geography, and more. Educators can join the National Geographic Educator Certification program, a free professional development program that recognizes pre-K through 12 formal and informal educators committed to inspiring the next generation of explorers, conservationists, and change-makers. New online courses will be added to the website, and there is information on the site regarding grants for educators. natgeoed.org

Sci-News

Catch up with some of the latest science discoveries with Sci-News, which covers areas of astronomy, space exploration, archaeology, paleontology, biology, physics, medicine, genetics, geology, and more. Read about blue diamonds in the Earth's mantle, new ideas about plate tectonics, volcanic crystals that could help predict eruptions, and more. sci-news.com/news/geology

Junior Activity: Crystal Growth with Borax

Source: Scientific American scientificamerican.com/article/bring-science-home-crystals/

Background

Chemical reactions are a common occurrence. One example is when iron reacts with oxygen in the air or water, creating rust. Chemists use chemical reactions to change one chemical compound into another, sometimes forming multiple products, or to separate one compound from another. The recrystallization process can be used to do this. Recrystallization occurs where a solution of compounds is dissolved in hot water, and when it is cooled, one substance crystalizes (becomes crystals), separating it from the rest of the solution.

Crystals appear as the mixture cools because of solubility. Solubility is defined as the largest amount of something (solute) that can be dissolved in something else (solvent), such as dissolving Borax in water. The solubility of most solids increases with temperature, meaning that more Borax can be dissolved in hot water than cold water. When the hot, saturated mixture cools, it contains more Borax than can be contained by colder water, so Borax falls out of the mixture, as crystals.

Materials

- Large bowl
- Ice cubes
- Water
- String
- Scissors
- Two pencils
- Two Mason Jars or large drinking glasses
- Cooking pot
- Borax (available in the detergent aisle of grocery stores)
- Measuring tablespoon
- Plastic wrap
- Hot plate

Safety

- Caution and adult supervision are advised when handling Borax. It is harmful if swallowed, inhaled, or contacts eyes, and on rare occasion touching it can result in rashes. Because Borax is harmful if inhaled or contacts eyes, it is advised to not dissolve it with boiling water.
- Teachers should operate the hot plate.

Preparation

- Fill the large bowl halfway with ice cubes and then add water until the bowl is about 3/4 full.
- Cut two pieces of string, each one slightly longer than the height of the jars or large drinking glasses. Tie the end of each string around each of the two pencils. Adjust the lengths so that when the pencil is laid across the top of a jar or drinking glass, the string end hangs just above the bottom of the jar. Make the strings equal length.

Procedure

1. Fill a cooking pot with enough water to nearly fill both jars.
2. Bring the water to a boil on the hot plate. Once the water boils, turn the burner off.
3. Add one tablespoon of Borax to the water and stir until it dissolves. Continue to add one tablespoon at a time until no more dissolves. You will probably need about three tablespoons of Borax for each cup of water.
4. Record your observations.
5. Carefully pour equal amounts of the saturated Borax solution into the two jars. Each jar should be about 3/4 full.
6. Lay a pencil across the top of each jar so that the string hangs down into the saturated solution.
7. Cover the tops of the jars with plastic wrap.
8. Leave one jar undisturbed on a flat surface at room temperature.
9. Place the second jar in the bowl full of ice. If needed, adjust the water level in the bowl so that the water reaches at least 3/4 up the jar, but is not so high that it goes into the jar.

10. Let the jars sit for at least five hours. Check the bowl of ice regularly and add ice if it has melted.
11. Check on the jars hourly to see how the crystals are forming. Record your observations.
    - Are crystals forming on the side of one of the jars?
    - Are crystals forming in one jar before the other?
12. After at least five hours, carefully remove the pencils and observe the crystals on the strings.

Discussion

Consider how the size, shape, and number of crystals on each string compare with one another. Consider why there might be differences.

Senior Activity: Metal Processing with Paper Clips

Background

When we look closely at many types of metals, we see what look like grains in the metal. These are individual crystals that form the metal. These crystals, or grains, have boundaries where the pattern gets broken or disrupted. We sometimes call these boundaries "defects" or "dislocations."

The metals we use in our everyday lives have been processed, their crystalline structures rearranged to meet the requirements of a product. The three principle ways of processing are referred to as the "triple treat" by materials scientists. These involve different combinations of heating the metals, chemically treating them to alter their composition, and physically beating them to alter their interior structure.

For example, when blacksmiths forge horseshoes or implements, they use heat to rearrange the grains in the metal and add carbon from the surrounding atmosphere. The heat erases boundaries or dislocations within the atomic structure, allowing the atoms to realign and build new links, growing the grains. Larger grains make the metal more ductile, or easier to bend, since there are fewer boundaries or dislocations to resist forces. When they beat or bend the hot iron, blacksmiths not only change its physical shape, they also introduce new dislocations or defects into the structure. Heating and "quenching" or rapidly cooling the metal fixes these new dislocations or defects in place, hardening the metal, but making it brittle. Heating followed by slow cooling anneals or softens the metal, facilitating shaping, stamping, or forming processes.

How much heat, how much carbon, how much hammering, and how the iron is cooled all have different influences on the iron, giving rise to different qualities, depending upon the combinations. This is one of the simplest ways in which we work with metals to give them the desired properties.

More sophisticated techniques of heating and treatment produce metals that are mixed compounds, or alloys of different metals. For example, alloying iron with carbon, chromium, nickel, molybdenum, titanium, or other elements, results in different types of steel, ones with extra strength, hardness, rust-resistance, malleability, or other properties.

Activity Outline

Students will learn that we can change the structure of metals and their properties, that human activities have effects at the microscopic scale, and that properties of metals relate to their structure and how we "treat" or process metals.

Materials

- 5 small butane torches
- 5 boxes of large paper clips (or bobby pins)
- 5 ceramic plates
- 5 pairs of pliers
- 5 large beakers
- 5 pairs of silicone safety gloves
- Optional: Several strands of thick copper wire

General Instructions

1. Split the class into small groups.
2. Set up five work stations, each having a beaker of water, a butane torch, a pair of silicon safety gloves, a ceramic plate, a box of large paper clips (or bobby pins), and pliers.
3. Have students read their activity instructions before beginning so they understand each step.
4. As a class, come together at the end and share observations.

Safety

- Students with longer hair should have it in a ponytail or pulled back.
- Students should exercise caution with the butane torches and the heated paper clips.
- Students should wear silicone safety gloves when handling any heated materials.
- The instructor should undertake the annealing and quenching activities as a full class demonstration if safety or the capability of the students is a concern.

In this activity, students will witness the impact simple processing has on paper clips. By bending a paper clip, students will discover how work hardening (or cold working) a metal can make it stiffer or less ductile; how simple heating (or annealing) can make it more ductile (or flexible); and how quenching can make it more brittle.

Safety Note: In this experiment, students will use a small butane torch. Please follow all safety procedures and do not point the torch or flame at any person or object. The only objects that should touch the flame are the paper clips. Be sure to tie back any loose hair in a ponytail.

Read through the entire set of instructions before beginning.

Procedure

1. Take three paper clips and straighten them out.
2. Bend one straightened paper clip about 2 cm from the end, and then straighten it. Observe how the paper clip feels as you straightened it.
3. Bend the same paper clip at the same spot again. Note how it feels.
4. Count the number of times you can bend the paper clip back and forth at the same spot until it breaks. Record that on your observation sheet.

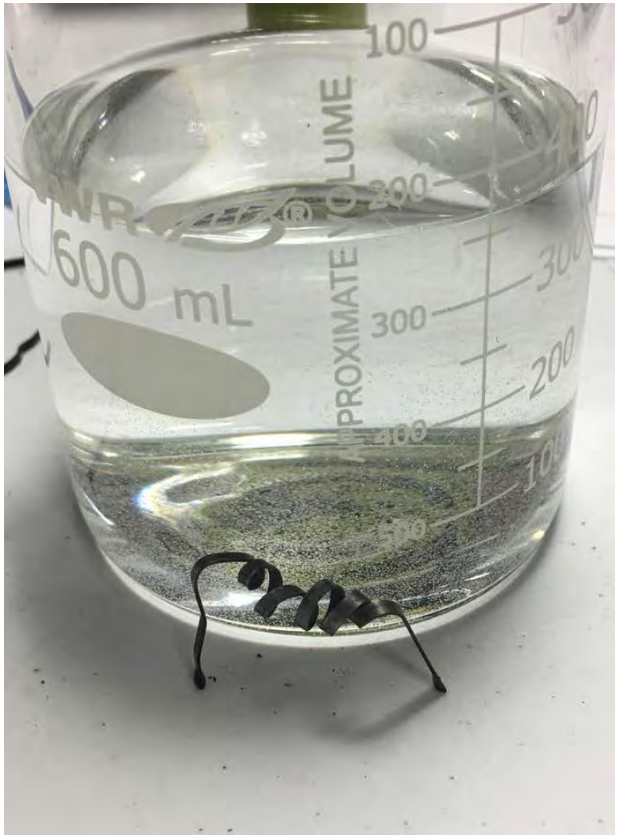
   Note: You are experimenting with work hardening. Every time you bend or strain the metal, you create small dislocations or defects inside the crystal structure, making it stiffer and more brittle.
5. Wearing silicon safety gloves, one team member places the end of a second straightened paper clip in the pliers.
6. A second team member turns on the butane kitchen torch by pressing and holding the trigger button. ***Safety Note: Keep the torch still, and do not point it at any object or individual.***
7. Using the pliers, hold the straightened paper clip so that about half of the clip is in the flame. Hold it there until it is glowing hot (5 to 10 seconds).
8. When the paper clip end is glowing, release the torch trigger to turn it off.
9. Place the paper clip on the ceramic plate to let it cool. This heating and slow cooling is called annealing.
   Safety Note: Do not touch the hot clip for at least two minutes.
10. Fill the beaker with water.
11. Repeat steps 5 to 8 with the third straightened paper clip.
12. When the clip is glowing hot, plunge it into the beaker of water. This is called quenching.
13. Repeat steps 2 to 5 with the second and third straightened paper clips.

When we anneal the steel (heat it and allow it to cool slowly), we add energy to the atoms of the crystals. This helps the grains reset and breaks up some of the defects in the metal, making it easier for the grains to slide past each other. As the metal cools, the carbon in the steel gets moved to the edges of the grains.

When we heat and quench the steel (heat it and then cool it quickly), we add energy and reorganize the crystals in the grains, but then trap the carbon atoms inside the grains. This creates more defects and dislocations that make the steel harder to bend and move.

Tips for Instructors

1. Before the activity, discuss "Background" information and assess student pre-lesson knowledge level.
2. Ask students to identify examples of different types of the same metal: those with the same composition but with different properties such as hardness or malleability.
3. Extend the experiment by heating copper wire.
4. Encourage students at the individual stations to ask questions about what they are modelling.
5. Ask questions such as
   - Have you seen this sort of process done elsewhere–heating a metal and then cooling it quickly (quenching)?
   - What do you think might be going on with the crystals in the metal?



Paper Clip Treatment Observation Log

Sample	Observation: first bending	Observation: second bending	Number of times it bends before it breaks
Paper Clip 1 **(work hardened, or cold hardened)**			
Paper Clip 2 **(heated and slow cooled–annealed)**			
Paper Clip 3 **(heat treated and quenched)**			

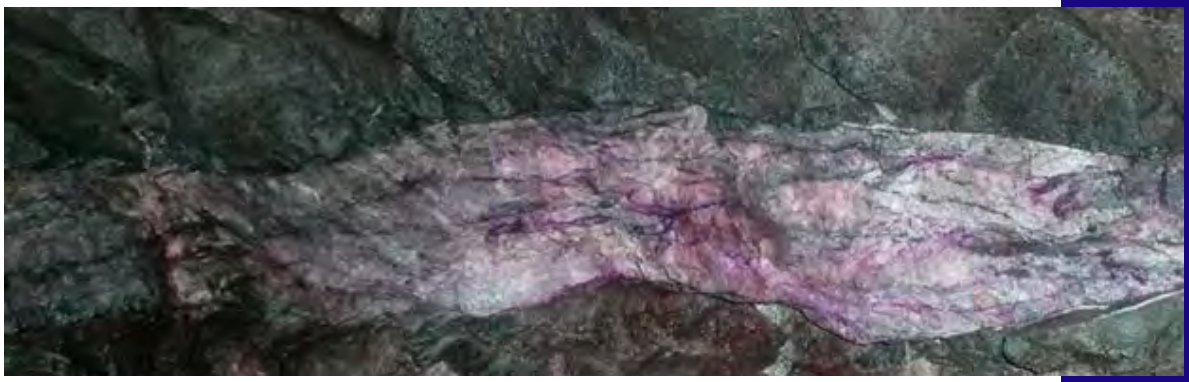
Geoscience Aware Challenge

The Geoscience Aware Challenge was created for the Girl Guides of Canada, Manitoba Chapter, through a partnership comprising **Mining Matters**, Girl Guides of Manitoba, the Government of Manitoba, and the Canadian Geoscience Education Network. The Challenge activity book explores a series of Geoscience Literacy Principles through more than 30 hands-on learning activities. Guides, ranging from Sparks through to Rangers, earn their Challenge badge by completing a requisite number of activities, depending on Guide level (Sparks = 7, Brownies = 8, Guides = 9, and Pathfinders and above = 10), associated with each of the stated Geoscience Literacy Principles.

In April 2018, **Mining Matters** delivered a training workshop to 40 Guide Leaders, to prepare them to implement the Challenge with their Groups. The Challenge officially launched in Fall 2018 and the first cohort of Guides are already on their way to earning their crests. The activities will be made available to educators in the future.

Cobalt: A Critical Element

(Co) Atomic No. 27
Top Producers: Democratic Republic of Congo, Russia, Australia, Canada, Cuba



It was a nuisance, a trouble-causing goblin or gnome. It was the source of rich beauty. Now, critical to a multitude of applications, cobalt is referred to as a technology-enabling element, listed by the European Union as a critical element, and recognized by the USA as a raw material of strategic importance.

Cobalt, from the German "kobold," meaning goblin, caused grief for medieval miners digging for silver ore, which also contained cobalt. The miners were affected by mysterious toxic vapours when they smelted the ore; they blamed arsenic-containing fumes on goblins.

For over 2,600 years, cobalt oxides and silicates have provided a rich blue found on ancient Egyptian artifacts, in Roman glass, and on Chinese Tang (600-900 AD) and Ming (1350-1650 AD) dynasty pottery. In fact, until the 20th century, cobalt was used primarily for pigments. Until the 1700s, these pigments were attributed to bismuth, copper, iron, and arsenic.

In 1735, cobalt as a metal was isolated by G. Brandt, a Swedish scientist, and identifies as a bluish-grey, shiny, brittle metallic element with iron-like magnetic properties. It was the first metal to be discovered since prehistoric times and the first metal with a recorded discoverer. Nearly 200 years later, in the 1930s, cobalt found its place as a key component in Alnico magnets, the first powerful permanent magnets. Cobalt is one of three known metals with naturally occurring magnetism, the other two being iron and nickel. It retains its magnetism at temperatures up to 1,121°C.

Today, we know that cobalt produces vibrant colours, is wear resistant, oxidation resistant, ferromagnetic, and conducts electricity. It is also a bio-essential element and makes up the backbone of vitamin B12, vital to blood formation and the nervous system.

According to the US Geological Survey, as of 2018, about 70 per cent of annual cobalt production makes its way into superalloys, mainly in aircraft gas turbine engines; cemented carbides for cutting and wear-resistant applications; and rechargeable lithium-ion batteries, essential to smartphones, laptops, and green technology such as electric cars. The remaining 30 per cent goes to a variety of chemical applications, including healthcare applications, such as medical diagnostics, pharmaceuticals, and fermentation processes (bio-mass), and ceramic and paint industries.

Until the 1970s, Norway, Sweden, Hungary, and Germany (Saxony) were the main producers of cobalt. From then on, the African Copper Belt became the major source, producing cobalt as a by-product of copper and nickel mining. Today, the Democratic Republic of the Congo (DRC) holds over 50 per cent of world reserves and is responsible for nearly two-thirds of global cobalt output. With global demand expected to swell, the search is on for further resources.

This is good news for Cobalt, Ontario, a town that sprang into existence in the early 1900s due to major silver discoveries. Named for the beautiful "cobalt bloom" indicative of the ore that yields silver, nickel, and cobalt, the town has a bright future, with the area once again turning into a hotbed of exploration, this time for cobalt. New ground is being examined and old silver mines are being reopened, some with high grade deposits with three times the concentration of cobalt deposits in the Central African Copper-Cobalt Belt.

Northeast of Cobalt, in Quebec's Abitibi region, the Dumont Nickel-Cobalt Project boasts the largest undeveloped nickel reserve and second largest undeveloped cobalt reserve in the world. The project is one of the few large-scale, shovel-ready projects positioned to deliver large quantities of nickel and cobalt to market in the next few years.

Mining is one of Canada's primary industries, producing precious metals (gold, silver, platinum) and diamonds; base metals (iron, copper, lead, zinc, nickel); energy minerals such as coal and uranium; and industrial minerals (limestone, rock salt, potash, gypsum). Cobalt has only recently stepped into the picture, but it's already adding a rosy bloom to the country's mining future.

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Mining Matters is a charitable organization dedicated to educating young people to develop knowledge and awareness of Earth Sciences, the minerals industry and their roles in Society. Since 1994, **Mining Matters** has reached an estimated 700,000 teachers and students through resources that promote the vital role rocks, minerals, metals, and mining play in everyday life. **Mining Matters** prides itself on building long-term partnerships with teachers by providing relevant, accurate, and authentic Earth science resources for the classroom, designed by teachers for teachers.

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