Girl Guides of Canada
Guides du Canada

Manitoba Council

# GEOSCIENCE AWARE CHALLENGE

**Acknowledgements**

Mining Matters, The Canadian Geoscience Education Network (CGEN), Girl Guides of Canada-Manitoba Council, the Manitoba Geological Survey, the Government of Manitoba, and Women Who Rock, extend appreciation to the British Columbia Girl Guides Council and to Ocean Networks Canada/Ocean Aware Challenge for their 'Challenge' model and template which inspired this Manitoba Geoscience Aware Challenge handbook. Publication of the Manitoba Geoscience Aware Challenge Handbook was made possible with funding support from Women Who Rock. Special thanks to The Earth Science Literacy Initiative (earthscienceliteracy.org) for their Earth Science Literacy Principles, which guided and contributed 'Big Ideas' and 'Supporting Concepts of Earth Science'.

# Contents

# Introduction

Welcome to the Manitoba Geoscience Aware Challenge, a joint project by Mining Matters, the Canadian Geoscience Education Network (CGEN), Manitoba Girl Guides of Canada and the Manitoba Geological Survey's Manitoba Rocks! mineral education and awareness program.

## About this Handbook

This handbook outlines principles of geoscience and fun activities to help Guiders explore each principle. It includes detailed instruction and activities to help you dig deeper into Earth science. You are welcome to substitute your own activities to achieve learning outcomes for each principle, or to add your own geoscience-themed learning activities in and around Manitoba.

## Manitoba Geoscience Aware Challenge Partners

**Mining Matters** (MiningMatters.ca) is a charitable organization dedicated to bringing knowledge and awareness about Canada's geology and mineral resources to students, educators and the public. The organization provides current information about rocks, minerals, metals, mining and the diverse career opportunities available in the minerals industry. Mining Matters offers exceptional educational resources that meet provincial curriculum expectations, created by educators and Earth science experts. Since 1994, Mining Matters has reached an estimated 650,000 teachers, students and members of the public.

**The Canadian Geoscience Education Network (CGEN)** (earthsciencescanada.com/cgen) is the educational arm of the Canadian Federation of Earth Sciences (CFES). CGEN exists to stimulate the development of geoscience awareness in Canada and to co-ordinate the efforts of the Canadian geoscience community. The network acts as a forum for discussion related to geoscience education in Canada. Since programs related to education in schools are best delivered on a local scale, CGEN is a collective of grassroots activists who deliver programs in their local areas.

**Girl Guides of Canada** (girlguides.ca/web/mb) Girl Guides of Canada – Guides du Canada (GGC) continues to spark the imagination of girls to take their place in the world and take action on what matters to them. As role models, GGC's adult members support girls to achieve and succeed through fun, adventures, challenges and international experiences. Guiding plays an important role in communities right across Canada and has been active in Manitoba since 1910.

**Manitoba Geological Survey (Manitoba Rocks! program):** (ManitobaRocks.info) The Manitoba Geological Survey delivers a treasure trove of geoscience information and supports an exciting range of activities to facilitate mineral and petroleum exploration in the province, to encourage resource sustainability, and to provide ongoing mineral education and public awareness about the province's rich geological history and potential. ***Manitoba Rocks!*** focuses on geoscience for everyone by encouraging kids of all ages to explore and learn more about the amazing Earth under our feet, and the value and importance of rocks and minerals to our everyday lives.

**Women Who Rock** (WomenWhoRock.ca) is an organization with a mission to empower women and improve gender diversity in the mining industry. Their unique annual Auction for Action connects aspiring young women with some of the most celebrated leaders in the mining industry, developing mentoring relationships to inspire the next generation of mining professionals. We wish to thank Women Who Rock for their generous support of the Geoscience Aware Challenge.

## Purpose, Participants, Activity Suggestions

This **Geoscience Aware Challenge** is designed to get Manitoba Guiders thinking about the Earth under their feet in new ways, by using the principles of Earth science and geoscience. Bringing geoscience to life for Girl Guides in Manitoba can take place with or without participants having former knowledge about the subject. This challenge aims to inspire awareness, understanding and curiosity about Manitoba's unique geological history and landscape, and the Earth's fascinating geology, through hands-on activities, observations and exploration.

The challenge is designed for Sparks, Brownies, Guides, Rangers and Pathfinders. Rangers and Pathfinders can also earn this challenge by leading a younger group through it. The challenge can be completed over a couple of unit meetings, a day camp, a sleepover, or a full weekend camp.

You are encouraged to explore the Earth and geoscience in a way that works for **YOU**, either by using the activities listed or by completing other activities that are related to or meet the principles.

How you choose to approach each meeting is up to you. Just be sure to explore geoscience in Manitoba and most of all – have fun! You may also wish to consider visiting the following Manitoba geo-sites. (See Principle 7)

**Agate Pits** – The Souris Rock Shop, Souris, MB
**Canadian Fossil Discovery Centre** – Morden, MB
**Ed Leith Cretaceous Menagerie** – University of Manitoba, Winnipeg, MB
**Heritage North Museum** – Thompson, MB
**Manitoba Museum** - Geology & Paleontology – Winnipeg, MB
**Northern Manitoba Mining Academy** – Flin Flon, MB
**Oak Hammock Marsh Interpretive Centre** – 20 km north of Winnipeg, PTH 67
**Snow Lake Mining Museum** – Snow Lake, MB
**Stonewall Quarry Park Heritage Arts Centre** – Stonewall, MB

**VIRTUAL TIP:**
For more fun activity ideas, try a Google® search of Manitoba minerals, rocks, and locales.

# Participants (SBGPR)

## Sparks (ages 5 to 6)

Sparks generally meet once a week for an hour. In Sparks, girls are encouraged to try a bit of everything and begin discovering their individual skills, talents and interests. Girls will make lots of new friends, start earning badges and begin to learn all kinds of new skills in a safe and fun atmosphere.

## Brownies (ages 7 to 8)

Brownie units meet once a week, usually for an hour and a half. The hands-on Brownies program is all about encouraging girls to develop their own identity and positive relationships with others. Brownies gain confidence by learning skills that they can use in their daily lives and they develop a commitment to their communities through service projects and special events. Programming covers safety and healthy choices, science and technology, the arts and eco-awareness and camping.

## Guides (ages 9 to 11)

Guide units meet once a week, usually for two hours. In Guides, girls strengthen their leadership skills by taking the lead in unit activities, learning to organize events and teaching each other new skills, all while having fun with girls their own age. The Guide program includes activities dealing with cyber safety, anti-bullying, self-esteem, health and fitness, and environmental sustainability. Guides also have opportunities to take action on issues important to them and to make an impact in their community through service projects, such as tree planting and volunteering at local food banks.

## Pathfinders (ages 12 to 14)

Pathfinders meet once a week, usually for two hours. The Pathfinder program allows girls to take the lead and become active in the causes they believe in. In Pathfinders, girls will start to develop their independence, while also learning the value of teamwork. Girls have the chance to organize their own events and outings and are encouraged to explore new interests in diverse areas, such as photography and web design, fashion and interior design, engineering, community safety, technology and more.

## Rangers (ages 15 to 17)

Rangers focus on leadership and community involvement and a flexible program that allows teens to create their own unique Guiding experience. Young women begin to explore career options and learn valuable skills, such as budgeting and event planning. Rangers are also involved in active leadership opportunities like global development projects, eco-awareness initiatives and teaching skills to younger girls as Girl Assistants.

*Source: girlguides.ca*

## Activity Suggestions

The principles of geoscience literacy involve a variety of ideas and concepts, which are important for understanding our relationship to the Earth. Each principle includes a list of suggested activities to help explore the principle. Use activities found in the Activity Details section or choose to adventure, change, or expand and explore each principle in your own way. Handbook activities included in the Manitoba Geoscience Aware Challenge were created by Earth science and education specialists and sourced from several geoscience education organizations, including EdGEO (edgeo.org/en_CA/), Earth Learning Idea (earthlearningidea.com), and Mining Matters (MiningMatters.ca).

**PROGRAM NOTE:** To earn this challenge, Guiders are asked to complete activities from each of the seven principles of geosciences literacy. All levels of Guiding must complete at least ONE activity from each of the seven principles, plus additional activities from any of the principles, to meet the total requirements as indicated in the Program Connections - Geoscience Aware Challenge Tracking Grid. When challenge requirements have been met, please complete the Manitoba Crests Order Form at: Girlguides.ca/web/mb. Materials required for many of the activities are easily sourced at local grocery stores, drug stores and discount stores.

# Program Connections

Program connections are intended as guidelines to help fit this challenge into your regular program planning. In some cases, the Geoscience Aware Challenge activity may be similar to an activity in the program or the challenge activity could be used as an alternative to activities in the program. Use the **Geoscience Aware Challenge Tracking Grid** for each geoscience principle, to help monitor progress throughout the challenge. Above all, the program is intended to be flexible and fun. If an activity that girls are already doing meets the objectives or goals of the program area and if it is interesting and challenging, by all means credit girls for the activity as part of their program requirements. If you find another program area that is covered by an activity in this booklet, please don't hesitate to give credit for it as well.

# Program Connections

**Geo Fact**
Huge mammal remains and marine mammal remains (like Bruce the mosasaur*) have been discovered in Manitoba. Some of these remains are left-overs from the province's last Ice Age 25,000 years ago (*Visit DiscoverFossils.com Canadian Fossil Discovery Centre, Morden Manitoba)

## GEOSCIENCE AWARE CHALLENGE TRACKING GRID

| | Minimum # of activities to complete (include at least one per principle) |
|---|---|
| Sparks | 7 |
| Brownies | 8 |
| Guides | 9 |
| Pathfinders/ Rangers/Adults | 10 |

### Principle 1: The Earth is an ancient planet
### How the Earth formed

- ○ Toilet Tissue Timeline
- ○ Continental Jigsaw Puzzle
- ○ Earth Creation Stories
- ○ Stories from Rocks
- ○ Fossilize!

### Principle 2: The Earth has a fascinating geological history
### What Makes Up the Earth

- ○ Create a Fossil
- ○ Starburst® Rock Cycle
- ○ Edible Earth Layers
- ○ Oreo® Plate Tectonics
- ○ Unearth Your Inner Rockhound!
- ○ Three Rock Groups

### Principle 3: The Earth is a diverse system of rock, water, air and life
### The Earth keeps changing

- ○ I am a Carbon Atom
- ○ Different Volcanoes
- ○ Water in the Ground
- ○ Glaciers and Landforms
- ○ Human Earthquake
- ○ Folding and Faulting
- ○ What's up with Soil?

### Principle 4: The Earth's people and mining are interconnected
### How do minerals impact my daily life?

- ○ A Paste with a Taste
- ○ Product Matching Card Game
- ○ Rock Walk
- ○ Medicine from the Ground Up
- ○ Power to the People
- ○ Manitoba Rocks DIG IT! Minerals
- ○ Quarry and Pit Field Trip

### Principle 5: The Earth's mineral resources require our care
### How do humans impact the Earth?

- ○ Recycle, Reduce, Reuse Relays
- ○ Indigenous Earth Ideas
- ○ Operating a Surface Mine
- ○ Upcycle Lanterns
- ○ Manitoba by Satellite
- ○ Reclamation and Rehabilitation
- ○ Recycle your Mobile Phone

### Principle 6: The Earth has way mORE to explore!
### Explore the Earth by thinking like a geoscientist!

- ○ Cookie Mining
- ○ WHERE Challenge
- ○ Field Data Collection
- ○ What do Paleontologists do?
- ○ Go on a GeoTour in Manitoba
- ○ Get to know a Geoscientist

### Principle 7: Geoscience rocks!
### Expand your geoscience horizons!

- ○ Visit exciting mineral, rock and fossil sites, in Manitoba
- ○ Attend a meeting or field trip with a local rock and mineral club
- ○ Plan a Manitoba Provincial Legislative building field trip
- ○ Plan your own fun geoscience-related activity!

**PROGRAM REMINDER:** When you have fulfilled the challenge requirements, please complete the Manitoba Crests Order Form: www.girlguides.ca/web/mb

# Activity Details

## Principle 1: The Earth is an ancient planet
### How the Earth formed



## Principle 2: The Earth has a fascinating geological history
### What Makes Up the Earth



## Principle 3: The Earth is a diverse system of rock, water, air, and life
### The Earth keeps changing

## Principle 4: The Earth's people and mining are interconnected

### How do minerals impact my daily life?



## Principle 5: The Earth's mineral resources require our care

### How do humans impact the Earth?



## Principle 6: The Earth has way mORE to explore!

### Explore the Earth by thinking like a geoscientist!

## Principle 7: Geoscience rocks!
## Expand your geoscience horizons!

**SBGPR**

- ○ Visit exciting mineral and rock sites around Manitoba
- ○ Attend a meeting or field trip with a local rock and mineral club
- ○ Plan a Manitoba Provincial Legislative building field trip
- ○ Plan your own fun geoscience-related activity!

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## Principle 1:

# The Earth is an ancient planet

## *How the Earth formed*

1. Toilet Tissue Timeline
2. Continental Jigsaw Puzzle
3. Earth Creation Stories
4. Stories from Rocks
5. Fossilize!

# 1.Toilet Tissue Timeline

*(Source: DynamicEarth.co.uk)*

SBG

*The Earth is 4.6 billion years old and human experience is just a small part of this ancient timeline. The Earth is a dynamic planet and goes through many changes (including the formation of continents, extinctions and climate change).*

**Geo Fact**
For over 3,000 million years or 68 percent of the Earth's history, its only inhabitants were simple organisms, like bacteria.

## Activity Purpose:

To learn how the Earth changes over time.

## Supplies:

- One roll of toilet paper
- Crayons/coloured markers

## Directions:

Working in small groups, have girls construct a timeline by each carefully pulling and rolling out a toilet paper roll, and numbering the sheets to keep count. When girls come to an important event in Earth's history, have them carefully write the event on the tissue sheet using a coloured marker. Girls can also draw timeline symbols related to timeline occurrences (Note: Please use the geological chart in Activity 4 of this section as a guide or reference).

## Toilet Paper Timeline ( ~200 sheets)

| Sheets from START | Sheets from previous marker | Event |
|---|---|---|
| 1 sheet | 1 sheet | Planet Earth formed |
| 4 sheets | 3 sheets | Earth's core and crust formed |
| 9 sheets | 5 sheets | Oceans formed |
| 33 sheets | 24 sheets | First life appeared |
| 135 sheets | 102 sheets | Oxygen begins accumulating in the atmosphere |

## Toilet Paper Timeline ( ~200 sheets) - continued

| Sheets from START | Sheets from previous marker | Event |
|---|---|---|
| 170 sheets | 35 sheets | First animals |
| 178 sheets | 8 sheets | First vertebrates |
| 184 sheets | 6 sheets | First land plants |
| 185 sheets | 1 sheets | First land animals |
| 190 sheets | 5 sheets | First dinosaurs |
| 197 sheets | 7 sheets | Extinction of the dinosaurs |
| 200 sheets | 3 sheets | First humans |
| 200 sheets | 0 sheets | Present day |

## ACTIVITY INFORMATION: EARTH HISTORY EVENTS

(mya = millions of years ago)

**4600 mya** The Earth formed. Dust left over from the birth of the Sun clumped together to form our planet. Other planets in our solar system were also formed in this way at about the same time.

**4500 mya** Earth's core and crust formed. Dense metals sank to the centre of the Earth and formed the core, while the outside layer cooled and solidified to form the Earth's crust.

**4400 mya** The Earth's first oceans formed. Water vapour was released into the Earth's atmosphere by volcanic action. Vapour cooled and fell back to Earth as rain, and formed the Earth's first oceans (some water may have come by comets and asteroids).

**3850 mya** First life forms appeared on Earth - simple single-celled organisms. Exactly how life first arose is a scientific mystery.

**1500 mya** Oxygen began to accumulate in the Earth's atmosphere. Oxygen is made by cyanobacteria (blue-green algae) as a product of photosynthesis. For 2,200 million years, this oxygen was removed from the atmosphere as it reacted with iron, sank to the bottom of the sea and became trapped in rock layers. 1,500 million years ago the free iron ran out and oxygen began to be released into the atmosphere.

**700 mya** First animals evolved. These were simple, single-celled animals.

**530 mya** First vertebrates (fish) evolved.

**400 mya** First land plants evolved. Oxygen in the atmosphere reacted to form ozone, which formed a layer that served as a protective barrier from harmful rays from space. This allowed plants to grow.

**350 mya** The first land vertebrates evolved. With plants present on the land to provide a food source, animals rapidly followed. The first to venture onto the land were primitive amphibians, then reptiles.

**225 mya** First dinosaurs appeared.

**65 mya** Dinosaurs and many other species disappear (after-effects of a meteorite impact, or perhaps several impacts and resulting earthquakes, tsunamis, volcanic eruptions, which spewed tons of dust and acid into the atmosphere, creating a 'frozen' winter or Ice Age. Dust blocked sunlight, so plants couldn't grow. After the extinction of the dinosaurs, mammals advanced.

**0.13 mya** 130,000 years ago, humans appeared, leaving Africa around 35,000 years ago and moving around the globe. Human evolution is still pretty mysterious, due to gaps in the fossil record.

**25,000 to 11, 000 yrs ago** Manitoba was covered by a glacier that slowly began retreating. Explore and learn more at ManitobaRocks.info/TeensRock/history

# 2. Continental Jigsaw Puzzle

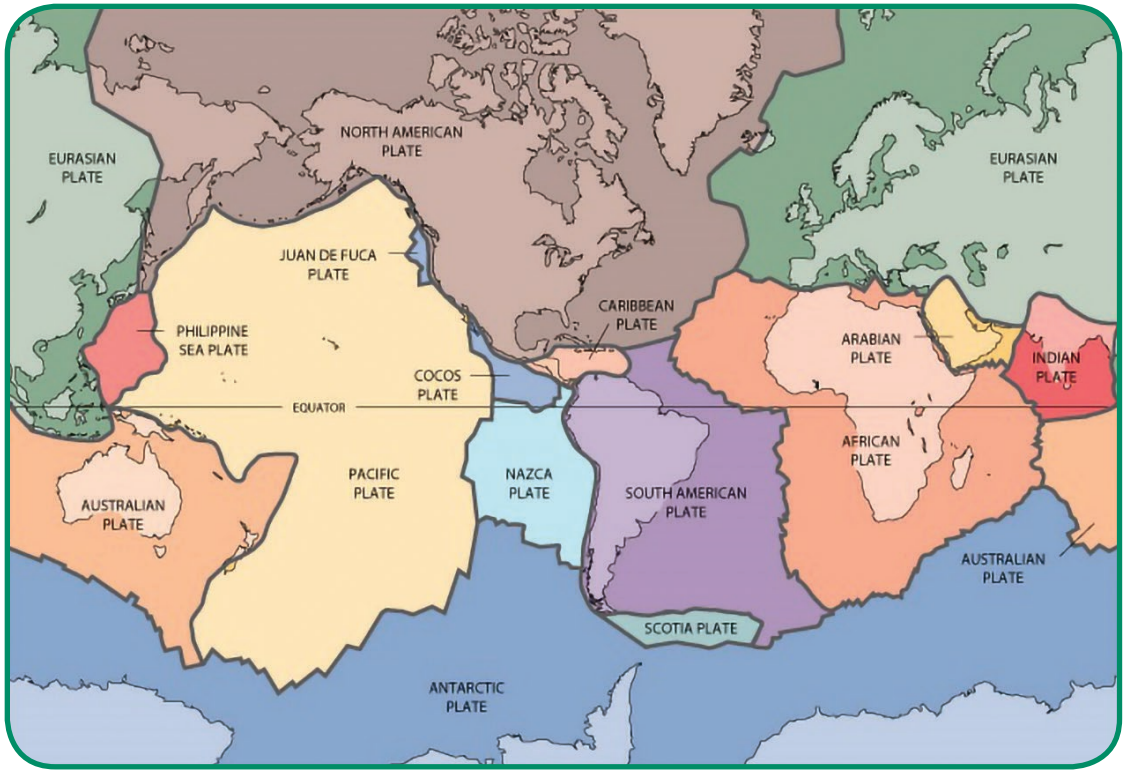
SBG

*(Source: EarthLearningIdea.com)*

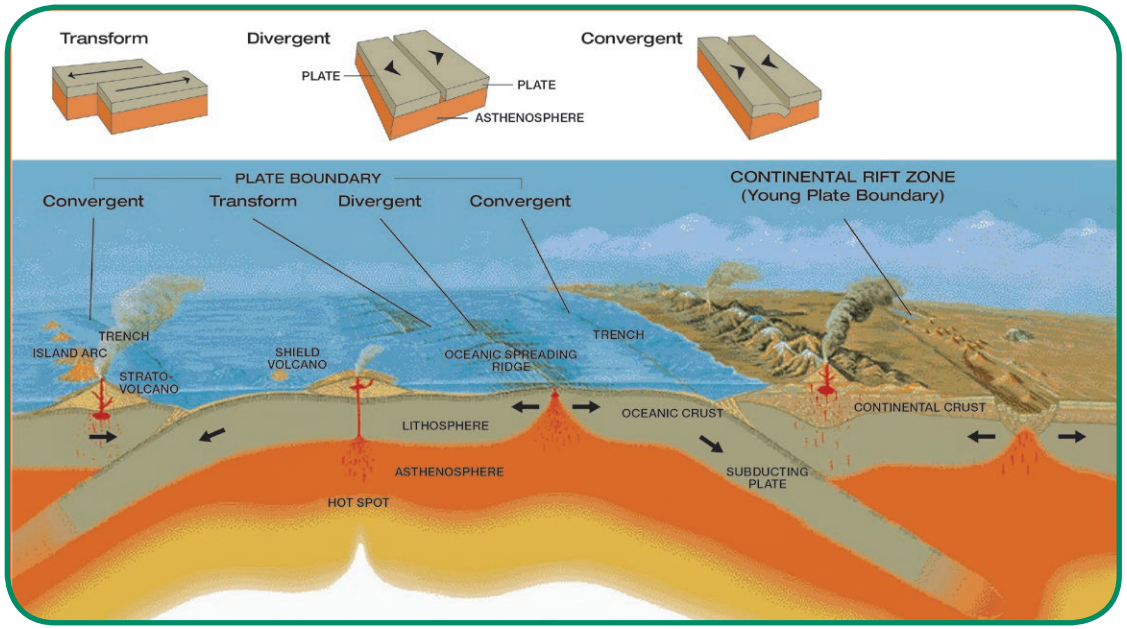
*The Earth's continents weren't always located where they are today. An early scientific theory, "continental drift" suggested that continents on the surface of the Earth wander across the ocean floor. The theory or idea of **plate tectonics** suggests the Earth's outer layer is made up of large moving pieces or plates. All of Earth's land and water sits on these plates, which are made of solid rock. Continents move slowly over geologic time, with evidence taken from the shape and geology of continental coastlines and studies like fossil distributions. In paleogeography (a study of the Earth's geographical features at particular times in the geological past), **Gondwana** or **Gondwanaland** is a name given to a landmass or ancient supercontinent, which may have existed 600 - 530 million years ago*

## Activity Purpose:

Girls learn and talk about continental drift theory and plate tectonics by using cut out jigsaw pieces (see: Activity Preparation) of the Earth's continents, and by reassembling the pieces into a former supercontinent by finding matching patterns. Girls learn the Earth has seven or eight major plates and several minor plates. Movement of the Earth at the site or boundaries where plates meet, determines the type of boundary created: **convergent** (destructive boundary with plates moving together); **divergent** (plates moving apart and sea floor spreads to create new crust); and **transform** (mostly horizontal movements of the Earth, as evidenced by earthquakes, volcanoes, mountain-building and ocean trenches).

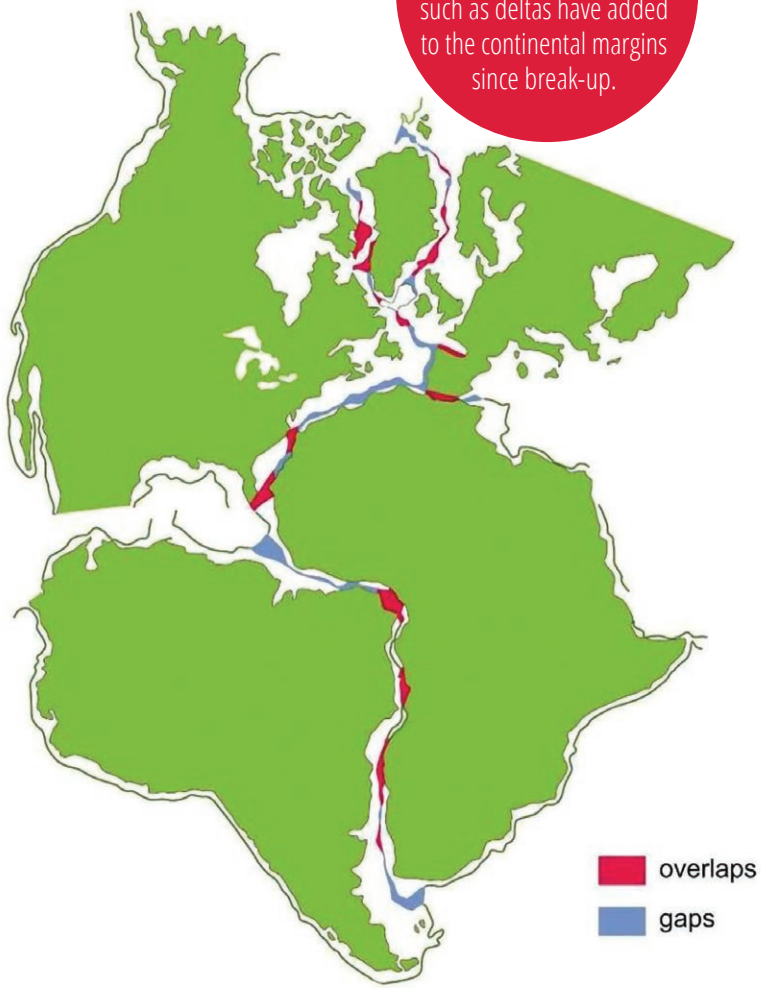



*(Source: U.S Geological Survey (UGS))*




*(Source: Plate Boundaries - Ocean Explorer.NOAA.gov)*

**Geoscience tip**
Most areas of overlap take place where features such as deltas have added to the continental margins since break-up.




This modern continental jigsaw sample shows the best fit map of margins of the Americas and Europe/Africa and how closely the jigsaw matches margins since break-up.

## Activity Preparation and Set-up:

Make your own sets of jigsaw puzzles by copying templates. Prior to your meeting, prepare enough sets of puzzles, depending on the number of groups of girls. Photocopy the map figures provided, fix onto light cardboard and cut out. Prepare enough sets for girls to be able to work in several small groups. Once sets have been created, they can be stored in envelopes and reused. Tip: Each of the seven landform pieces provided on the full page map can be cut out individually and photocopied at a larger size onto 8 ½ x 11" or 11x14" paper (for a larger jigsaw puzzle).

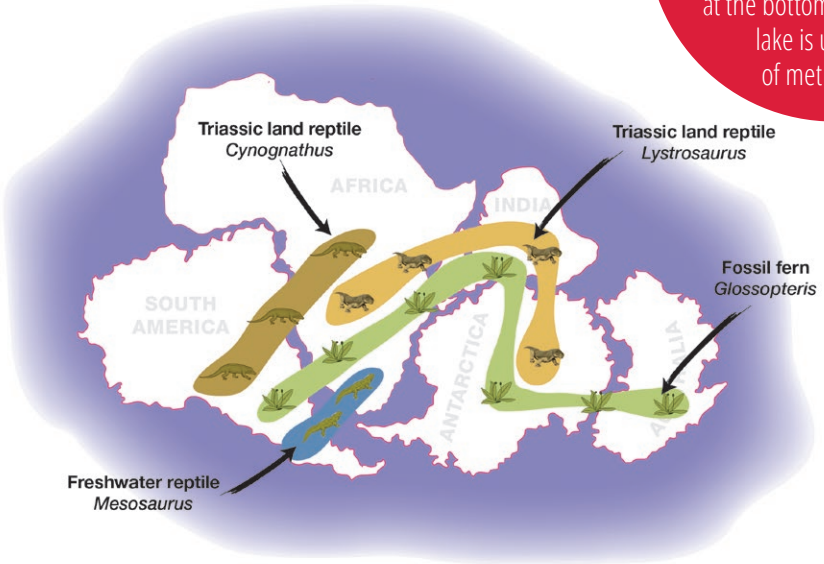
## Instructions:

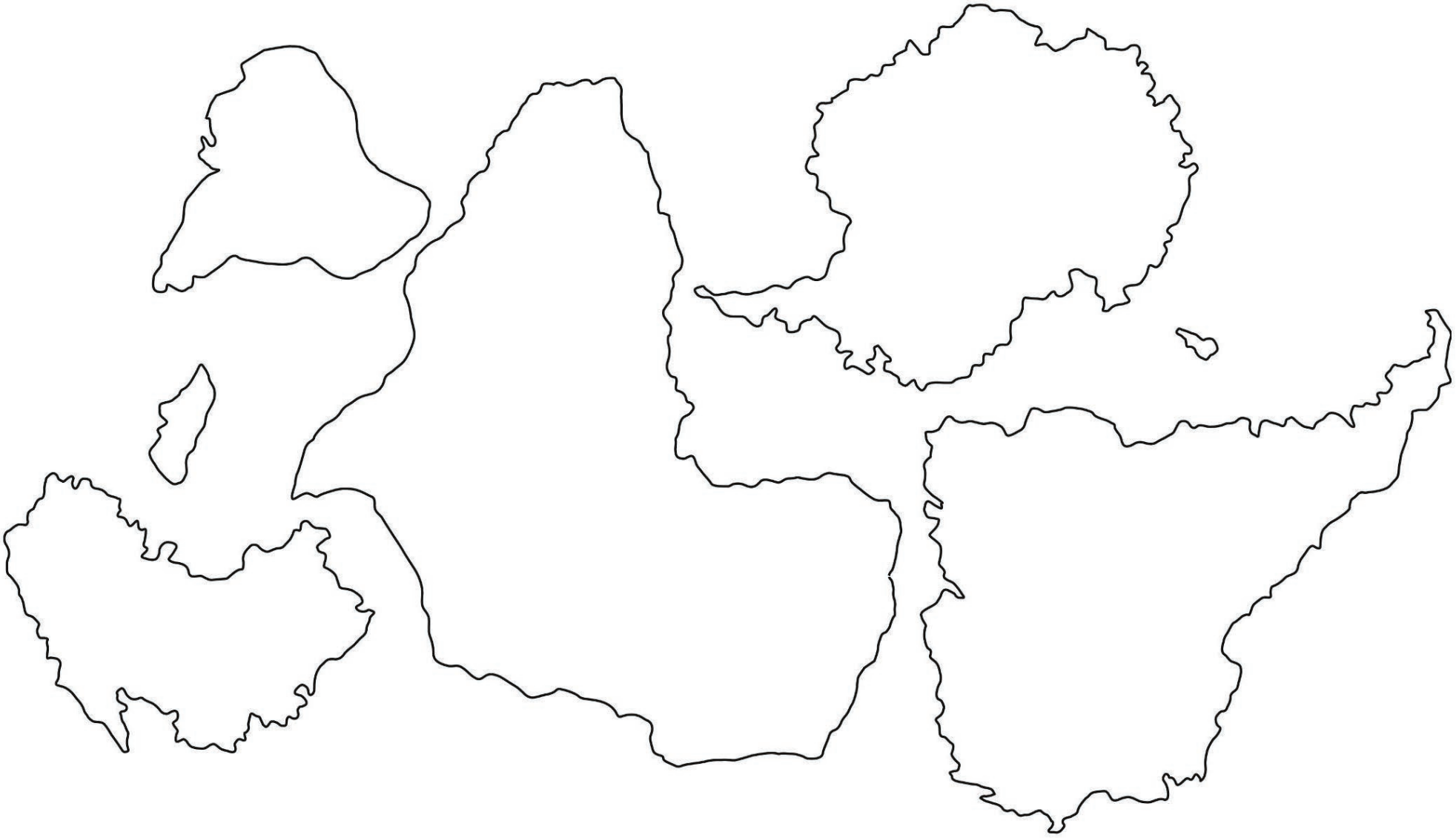
Divide girls into small groups and distribute puzzles, using one or more sets of the continents. Ask girls to try to reassemble the outlines to make the former super-continent (Gondwana – see sample). Suggest that they refer to the figure that illustrates the distribution of land/freshwater animals and plants in the continents of Gondwanaland. Once completed, girls can compare and contrast what they created with other groups. Girls can then compare notes and discuss what they learned about continental drift and plate tectonics.

**Geo Fact**

Glaciers or ice sheets once covered Manitoba and began to retreat 11,000 to 7,000 years ago, leaving Glacial Lake Agassiz. Silt and clay deposited at the bottom of the ancient lake is up to tens of metres thick.

## Distribution of land/freshwater animals and plants in the continents of "Gondwanaland"



# 3.Earth Creation Stories

SBG PR

*Cultures throughout time have shared unique ideas and theories about how life on Earth started and how the Earth was formed.*

**Activity Purpose:**
To explore creation stories of various cultures, including those of Indigenous peoples.

**Supplies:**
Different creation stories (See ManitobaRocks.info: Teens Rock, Directions page, 'Turtle Island')

**Directions:**

1. Do some research in advance (or for Guiders aged 9 and older, have girls conduct their own research) to discover various creation stories from different cultures (at least three). Represent the cultures of the girls in your group or the cultures of Manitoba. Look for stories or audio files, or ask an Indigenous community elder to visit the group and share their stories.
2. Read or listen to the stories. As you go through the stories, ask the girls to think about what beliefs may have led to these stories, including what was known or unknown at the time.
3. After the stories, have the girls compare and contrast the beliefs and stories. What are some similarities? What are some differences?
4. Girls may choose one or more of the stories to play act for the leaders or another group.

# 4.Stories from Rock

*(Source: Bringing Earth Science to Life, EdGEO)*

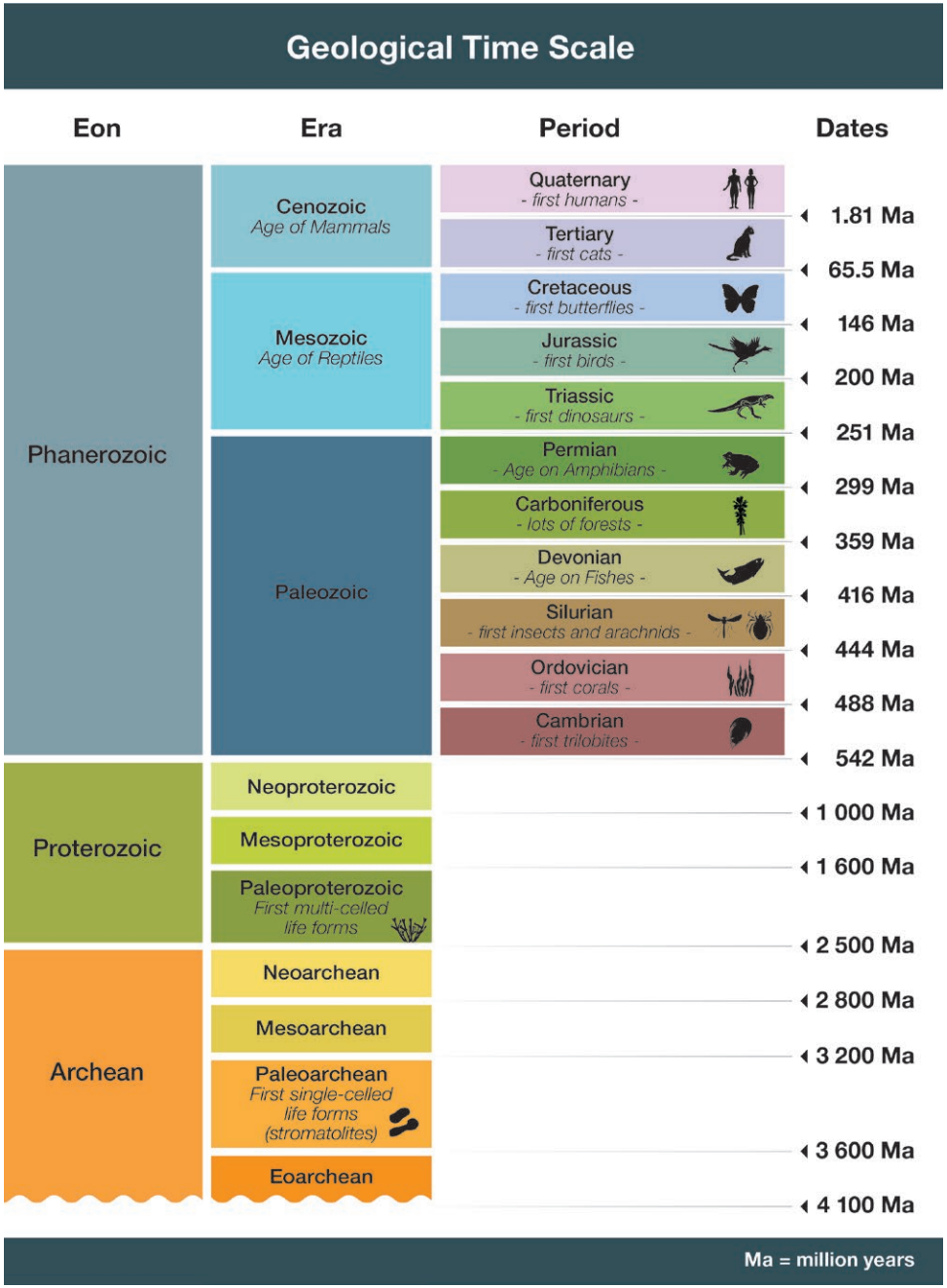
BGP

*Earth scientists can learn more about the Earth today by rebuilding ancient environments and studying and understanding how processes that are taking place now on Earth are the same as those that took place in the past. Different dating methods (e.g. radioactive dating or index fossils that connect with a known time period) can allow Earth scientists to be detectives and to identify where in the **geological time scale** various rocks come from, helping them retell Earth's past from evidence in rocks.*

**Activity Purpose:**
To explore and match evidence from rock layers to the geological time scale and interpret changes in the environment through time.

**Supplies:**

- Glue sticks
- Scissors
- Geologic time chart (included with activity)




*Geological Time Chart Source: ManitobaRocks.info (Kids Rock)*

## Directions:

1. For each Guide or group of Guides, print on large sheets of 11 x 14" or 11 x 17" paper, the Rock and Fossil Evidence table, with evidence from geological formations in southern Saskatchewan and Manitoba.
2. Cut out each box and have girls match rock and fossil evidence boxes to the corresponding period of the geological time scale. Once girls have the boxes in the correct order, have them glue them in place. Girls can describe what they learned about rock evidence and geological time.

## Table 1: Rock and Fossil Evidence

**Limestone** with inter-layered beds of halite (salt), clams and fossilized fish
390 million years

**Granite**
2.8 billion years

**Bentonitic shale,** muddy siltstone, tyrannosaurus fossil remains, fossilized pollen grains
66 million years

**Cream-coloured limestone,** occasional sandstone beds, marine snails and corals
170 million years

**Shale and mudstone,** single-celled algae fossils
500 million years

**Limestone and black shale,** corals and clam shells, shark's teeth
330 million years

**Glacial till,** mud containing pebbles and cobbles, primitive 5,000 year-old stone tools

**Limestone and lime mudstone, trilobite fossils**
480 million years

**Reddish sandstone and siltstone,** fossil remains of very early dinosaurs
250 million years

**Soft sandstone and siltstone,** coal beds, high iridium values in lower coal bed
65 million years

# 5.Fossilize!

*(Source: Earthlearningidea)*

GPR

*Earth is an ancient planet. Life first appeared on Earth 3.8 billion years ago and multicellular life evolved over a billion years later. Evidence of life appears in the rock record as fossils. The chances of an organism becoming fossilized are extremely small. Certain factors make fossilization of organisms more likely, such as animals living in a low energy marine environment, where fine sediment is being deposited, or being overcome by a catastrophic event (e.g., mudslide or burial in volcanic ash). The chances of a fossil being preserved for people to see and collect are even smaller. Weathering, erosion and human activity can destroy fossils.*

## Activity Purpose:

To help girls understand what a fossil is, recognize some commons fossils, learn how special conditions must exist for fossilization to occur and for fossils to survive. Girls learn that there are many reasons why organisms are not fossilized and even if they are, that there are also many reasons why fossils do not survive. Girls also learn that the player often has to go backwards and that not everyone can win. This reflects the reality of the process of fossilization and preservation.

## Activity Supplies:

- The Fossilize Game (included in this handbook)
- Game markers or counters (bingo chips)
- Dice (distribute one 'die' per group of girls.

**Leader's Note:** Photocopy and distribute cut out fossil pictures from the handbook, in advance, to help girls get to know the fossils in this activity. Keep the gold nugget card copied, but set it aside as a prize. Photocopy the game for use by each group of girls.

## Activity Setup:

1. Start by asking girls **'What is a fossil?'** (Answer: *A fossil is any preserved evidence of life, animal or plant, usually regarded as more than 10,000 years old. It may be the remains of the organism itself, like a sea shell, or it may be evidence of an organism, like a footprint or a burrow*).
2. Print and cut out the fossil cards (photographs of common fossils).
3. Discuss photos/fossils with girls to help them become familiar with the shapes, names, and identification of fossils.

## Instructions:

Divide girls into small groups. Give each group a copy of The Fossilize Game (included in this handbook). Girls use bingo chips or other game markers to move around the game board. Use one die per group of girls to play the game. The game is played as girls collect a fossil card whenever they land on a fossil on the game board.

**Leader's Note:** Encourage girls to read what happens to them as they move around the game board. The winner of the game receives the gold nugget card.

**Ammonite**
extinct sea creature related to octopus and squid

**Brachiopods**
sea creatures, fixed to the sea bed by a stalk

**Sea urchin**
sea creatures, similar to modern sea urchins, related to starfish

**Bivalve**
known as 'the devil's toe nail' because of its shape - similar to modern oysters

**Coral**
similar to modern corals

**Sea snail**
similar to modern sea snails

**Tree bark**
from an ancient, extinct tree

**Trilobite**
ancient sea creature related to horseshoe crabs

**Bivalve**
cockle shells

**Shark's tooth**
similar to modern sharks' teeth

**Ichthyosaur vertebra**
part of the backbone of a large sea reptile

**Gold nugget**
winner

## The Fossilized Game

## When the game has concluded, ask girls to answer the following questions:

1. What helped the sea creature to become a fossil?

- It was living in the sea.
- It was a creature with a shell or skeleton, which did not rot away.
- It was buried under layers of sand.
- The layers of sand slowly changed to rock.

2. What helped the fossil to survive?

- Some children found the fossil and took it to school.
- A geologist found the fossil and took it to a museum.

3. What prevented the sea creature from becoming a fossil?

- It was eaten by another sea creature.
- It was a jelly fish, which rotted away.
- The sea was rough and it was washed away.

4. What destroyed the fossil?

- The rock with the fossil was eroded away.
- People broke up the rock with the fossil and made it into concrete.
- The fossil was hammered to bits by a geologist.

## Principle 2:

# The Earth has a fascinating geological history

## *What Makes Up the Earth*

1. Create a Fossil
2. Starburst® Rock Cycle
3. Edible Earth Layers
4. Oreo® Plate Tectonics
5. Unearth Your Inner Rockhound!
6. Three Rock Groups

# 1.Create a Fossil

*(Source: Mining Matters)*

SBG

*Fossils are evidence of animals and plants that existed in the past. Fossils can tell scientists what used to be alive in a given area. A fossil forms when something dies and is buried in sediment, like clay or mud. Over time this sediment can become rock, preserving the organism.*

**Geo Fact**

Organisms buried in sediment may decay or dissolve away, leaving an empty cavity or a hole. If this empty space or mold fills with sediment, an (external) cast can be made. Molds and casts are three dimensional and preserve the surface contours of the organism.

## Activity Purpose:

To learn how fossils are formed.

## Supplies:

- Toy bugs, shells, or other small hard objects (for making an imprint)
- Plasticine®
- Ceiling spackle
- Vaseline®
- Paper or plastic plates
- Paint and paintbrushes (optional)
- Small magnets (optional)

## Directions:

1. Have each girl select a bug or shell to help them make a fossil. Each girl also gets a ball of plasticine® about the size of a small apple. Have girls slightly flatten the ball of plasticine®.
2. Cover the surface of the bug or shell with Vaseline® to prevent sticking.
3. Gently push the Vaseline® covered surface into the plasticine® and carefully remove the item used, to leave behind an imprint.
4. Fill the imprint with spackling and leave it to dry. This may take up to 24 hours (check packaging directions).
5. Once spackling is dry, remove the fossil from the plasticine®.
6. The fossil can be painted and mounted on a magnet or left as is.

# 2.Starburst® Rock Cycle

SBG

*The rock cycle is a model describing the formation, breakdown and reformation or restructuring of rock as a result of sedimentary, igneous and metamorphic processes.*

## Activity Purpose:

Create a sedimentary rock and transform it into a metamorphic rock with the application of pressure. Transform your metamorphic rock to an igneous rock when it is melted and cools. **Program Note:** This activity requires a Leader's assistance throughout.

## Supplies:

- Starburst minis® candy (assorted colours)
- Scissors
- Source of heat (e.g., toaster oven, hot plate, blow dryer)
- Tongs
- Wax paper cut into a 6-8" square
- Aluminum foil cut into a 8-10" square, with edges folded up like a dish
- Rock cycle chart (from Manitoba Rocks.info - Origins of Rock - provided)

## Rock Types

| Igneous | Metamorphic | Sedimentary |
|---|---|---|
| Derived from the Latin word for fire, igneous rock forms from the solidification of molten rock (magma or lava) and may form with or without crystallization.<br><br>*Intrusive* (plutonic) rocks solidify from magma under the Earth's surface; *Extrusive* (volcanic) rocks solidify, from lava, at the surface of the Earth. | Derived from the Greek words meta (meaning change), and morph (meaning form). These rocks form from the transformation of existing rock (metamorphism).<br><br>Existing rocks are changed physically or chemically as a result of exposure to heat, pressure or fluids. | Derived from the Latin word *sedimentum*, meaning to settle. Sediment is the term for the particles that accumulate to form a sedimentary rock. Sediment is formed by weathering and erosion of Earth materials. Sediments are then transported by water, wind, or ice to where they are deposited. |

## Directions:

**1.** Unwrap four Starburst minis® candies, each of a different colour. Leaders, help cut each piece of candy into nine-12 pieces. (These are your pebbles).

**2.** Pile up all pieces and mix them around like pebbles moved by wave action on a rocky beach.

**3.** Rub the palms of your hands together quickly for several seconds to warm them, then pick up the pile of candy and push the pieces together to form a ball. Your ball should look lumpy with the candy pieces visible. You have now made a **sedimentary** rock. Review the colours, texture and pattern. **Draw it!**

**4.** Leaders will next help girls use a heat source to soften the lumpy ball. Once it has been warmed, place it in the middle of the square of wax paper and fold the paper in half over it.

**5.** Once inside the wax paper, apply pressure to the candy with a rolling pin, placing something heavy on top of it, stepping on it, or whatever else you can think of! After you've applied pressure, remove the candy blob from the wax paper and fold it over. Then place the candy blob back in the wax paper and repeat the process of applying pressure. What does your rock look like now? What colour is it? Texture? Pattern? You have now made a **metamorphic** rock. **Draw it!**

6. Girls place the blob in aluminum foil for the next step, and create a dish with foil by folding up the sides.

7. Leaders will help girls use a heat source to slowly apply enough heat to completely melt (liquefy) the lump of candy.
**Program Note:** too much heat will cause the candy to burn and smoke, and could activate the smoke alarm.

8. Leaders will use tongs to remove the foil container from the heat source and place it out of reach to cool.

9. Once it is cool enough to handle, carefully peel the candy from the foil.

10. Discuss how the new candy is different from the original candy and refer to the rock cycle chart to support your explanation. What colour is your rock? Texture? Pattern? You have now made an **igneous** rock. **Draw it!**

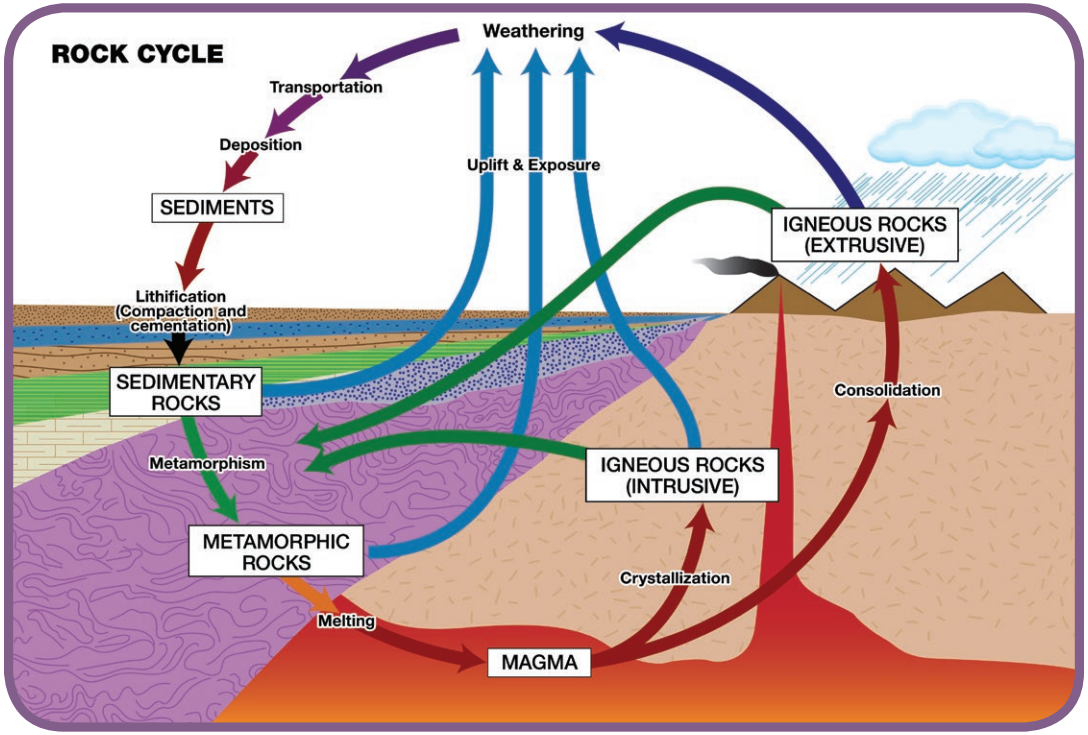
# 3.Edible Earth Layers

*(Source: sciencing.com)*

GPR

**Program Note:**

This is a fun activity to do outdoors during campfire season.



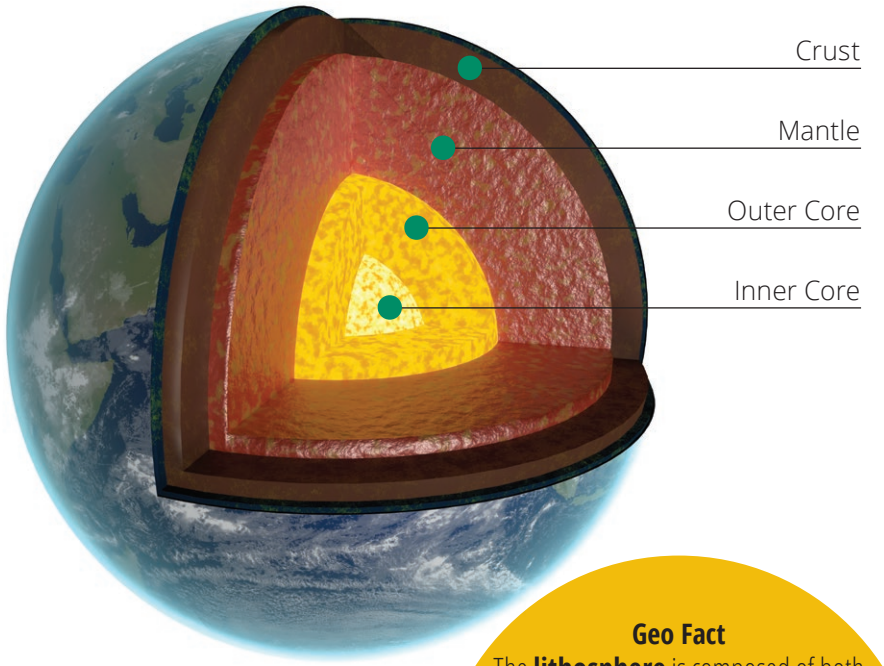

*(Source: ManitobaRocks.info (Kids Rock, Origins))*

## Activity Purpose:

To help girls learn the Earth's layers, this model doubles as a tasty snack. Instead of taking the form of a ball, the girls will place layers one on top of the other in a clear plastic cup, to be viewed as a cross-section. Each model should include the inner core, outer core, mantle and crust.

## Materials: (For individuals or pairs)

- Large clear plastic cup 7-12 oz. size
- Hard peppermint candy (inner core)
- Large marshmallow (outer core) (prepare and toast this item on site)
- Puffed rice squares (mantle) (on-site preparation)
- Crushed chocolate cookies (crust) (prepare in advance)




**Geo Fact**

The **lithosphere** is composed of both the crust and the portion of the upper mantle that behaves as a brittle, rigid solid. The lithosphere is about 100 kilometres thick. The **asthenosphere** is solid upper mantle material that is so hot, it behaves like melted plastic and can flow. The lithosphere flows or rides on top of the asthenosphere.

## Directions:

Girls use a large plastic cup to create a cross-section of the Earth, from its inner core to the mantle, based on an Earth model image. Leaders explain each step. Girls observe the finished layers or cross-section once complete, and can invert the cup to push out their cross-section and enjoy eating their Earth snack.

**1.** The leader explains that the **Earth's inner core** is actually a solid ball, composed mainly of iron and nickel. Have girls place the inner core (hard peppermint candy) at the bottom of their plastic cup.

**2.** Explain that the **Earth's outer core** is in fact an extremely hot molten layer, also composed mostly of iron and nickel. Have girls toast marshmallows and place a large toasted marshmallow representing the molten layer firmly around the inner core (hard candy) in the plastic cup. (This is a great outdoor activity to do at a local park or cookhouse, where campfires are permitted)

**3.** Explain that the **Earth's mantle** is a hard layer that moves very slowly around the outer core. It is the thickest layer.

(**Leader's Note:** Prepare puffed rice square mixture in a large bowl just before the activity, by heating and melting marshmallows and pouring the mixture over puffed rice. Cool the mixture, but leave it lukewarm, so it's easy for girls to mold and work with.)

Have the girls add the puffed rice square mixture. Girls each add about ½ cup of the warm rice/marshmallow mixture and press it down on top of the outer core (large toasted marshmallow) and inner core (hard candy) already in the plastic cup.

**4.** After forming the mantle, explain how the **Earth's crust** is the rocky surface layer of the planet. It ranges from about 5 - 800 km thick in places. Girls can add crust by pressing crushed chocolate cookie crumbs on top of the mantle (puffed rice mixture) in their glasses.

# 4.Oreo® Plate Tectonics

*(Source: adapted from "Fun with Food! Plate Tectonics and our National Parks)*
*Robert J. Lillie, Professor of Geology, Department of Geosciences, Oregon State University)*

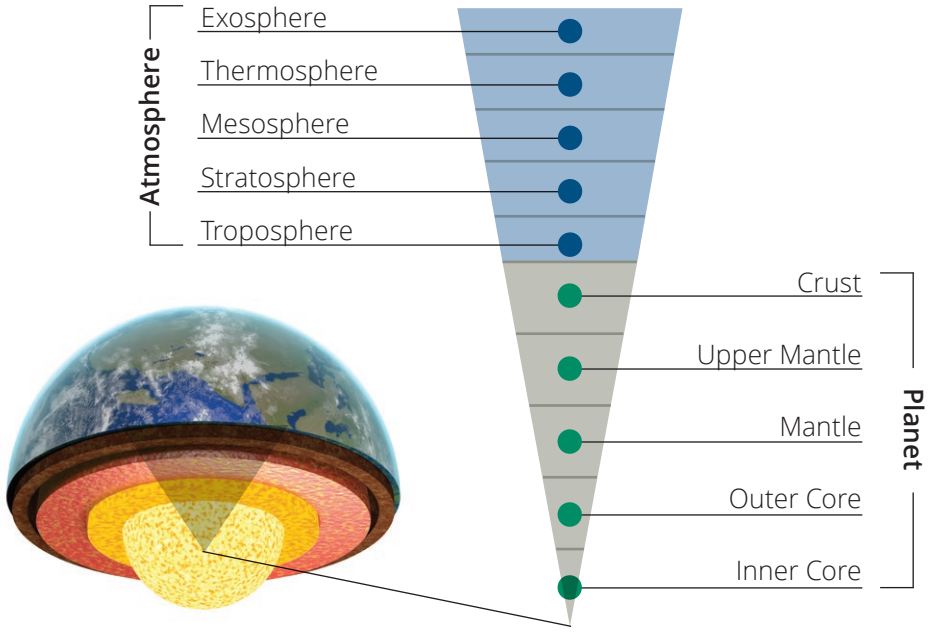
GPR

**Leader's Tip:**

Also review: Plate boundaries graphic, Activity 2 in this handbook

## Activity Purpose:

To learn how the Earth moves by using a model to demonstrate how tectonic plates shift and interact, as well as resulting landforms or geologic activity created by plate movements. This activity includes more geoscience terms for girls to learn (lithosphere, asthenosphere) and helps broaden knowledge of the Earth's structure.




## Supplies:

- One Oreo® cookie per student

## Directions:

1. Ask the girls which part of the cookie represents the lithosphere and asthenosphere (cookie=lithosphere; icing=asthenosphere).
2. Instruct the girls to twist off the top cookie.
3. Place the top back on the icing and twist it around. Slide it back and forth so that the cookie moves easily on top of the icing, simulating the lithosphere floating and moving on the asthenosphere.
4. To model or illustrate lithospheric plates, break the top cookie in half, creating two plates, where the break represents a plate boundary.
5. Create a divergent boundary by pulling the two cookie pieces away from each other.
6. Create a convergent boundary by pushing the two cookie pieces together. Instruct girls to push the plates gently into the icing to create a mountain range.
7. Create a transform boundary by sliding the two cookie pieces against each other (creating friction, earthquakes and land displacement).
8. Demonstrate subduction by pushing one of the two plates into the icing below the other piece.

# 5.Unearth Your Inner Rockhound!

**Program Note:**
Before doing this activity, girls should complete Principle 1, Activity 4, in order to have a concept and understanding of geologic time.

GPR

## Activity Purpose:

To challenge girls to discover their Inner Rockhounds by exploring and collecting rock samples from their neighbourhood or the area where Guide meetings are held. Girls can take a short trek, as a group or in pairs, or bring in samples of their own as part of the activity. Girls learn the geological history of a region in Manitoba by referring to Principle 1, Activity 4 in this handbook. Girls may also use the online web tools: Make-A-Map and Geo-Gallery (Kids Rock) or can dig deeper into the Dig It! minerals collection at ManitobaRocks.info to help study, compare and discuss findings. Girls may also use this opportunity to discuss any unusual rock samples they have found or collected in the past. Tip: Invite a guest speaker from the Mineral Society of Manitoba or Manitoba Geological Survey to help guide your knowledge and findings. Contact minesinfo@gov.mb.ca and also inquire about geological maps of Manitoba.

## Supplies:

- Field notebook
- Handheld GPS
- Geologic map
- Smartphone camera


## Directions:

Each pair or team collects at least two rocks from their neighbourhood, camp, school yard or elsewhere. For each rock, girls report in a notebook where and when they found it, describe it (appearance), photograph it, and explain how they think it was formed and how it relates to geologic processes in the area where it was found.

# 6.The Three Rock Groups

BG
PR

**Program Note:**
See Principle 2, Activity 2, Starburst Rock Cycle for rock types.

## Leaders:

Consider inviting a Manitoba geologist to help with this activity. Contact the Manitoba Geological Survey at 204-945-1119 or the Mineral Society of Manitoba, jrmyers@shaw.ca Tip: Check out the geology.com/rocks website for more great information on rocks and rock groups.

## Activity Purpose:

To examine and compare eight rock samples, match samples on a chart (provided) and complete a detailed description of the samples on the chart.

## Materials:

Rock Discovery Package (available from the Manitoba government), Visit ManitobaRocks.info – Kids Rock, Origins website, and use the rock chart included with this activity.

## Rock Chart

| Rock | Type | Clue | Detailed Description |
|---|---|---|---|
| Rhyolite | Igneous | Pink to red | |
| Granite | Igneous | Multi-coloured | |
| Sandstone | Sedimentary | Feels gritty, like sandpaper | |
| Shale | Sedimentary | Feels smooth, like hardened clay | |
| Limestone | Sedimentary | Beige and lumpy | |
| Quartzite | Metamorphic | Whitish | |
| Slate | Metamorphic | Thin layers, hard | |
| Marble | Metamorphic | Whitish, softer than quartzite | |

| Sedimentary |
|---|
| • Where |
| • How |
| **Metamorphic** |
| • Where |
| • How |
| **Igneous** |
| • Where |
| • How |

**Geo Fact**
One of Manitoba's lakes was formed by the impact of a rock (meteorite) falling from space.
Situated in the Canadian Shield area of Whiteshell Provincial Park, the lake is called West Hawk Lake.
It is Manitoba's deepest lake, with a depth of 115 metres (377 feet).

**TIP:**
**Use the Rock Cycle at ManitobaRocks.info (Kids Rock – Origins)** to describe environments where rock types are found.

## Principle 3:

# The Earth is a diverse system of rock, water, air, and life

## *The Earth keeps changing*

1. I am a Carbon Atom
2. Different Volcanoes
3. Water in the Ground
4. Glaciers and Landforms
5. Human Earthquake
6. Folding and Faulting
7. What's up with Soil?

# 1.I am a Carbon Atom

*(Adapted from Putting the Earth into Science, EdGEO)*

SBG

**Geo Fact**

The element carbon (C) is used for so called lead pencils, which actually don't contain any lead (Pb), but do consist of graphite mixed with fine clay. Graphite found in Manitoba is generally in Precambrian metamorphic rock, such as schist, gneiss and recrystallized limestone. Learn more at: ManitobaRocks.info Dig it!

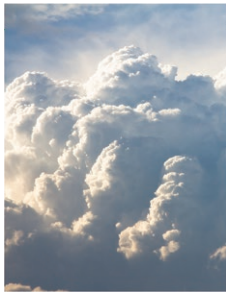
## Activity purpose:

To learn how a carbon atom moves through the Earth. Girls learn that the Earth is a complex system, including the carbon cycle, which impacts all areas of life.

## Directions:

1. Girls pretend to be carbon atoms and split up at one of 12 stations, then move through the stations according to information included on cards at each station. Girls move individually or in pairs through a timed carbon cycle tour, for 10 – 15 minutes.
2. At each station, girls roll a die to simulate a molecule of carbon's movement through various phases of the carbon cycle. Depending on what number they roll, girls may move to another station or stay where they are.

### Atmosphere



Roll Die – What happens to you?

Roll a...

1 or 4 - You're absorbed through photosynthesis into **land plants and trees.**

2 or 5 - You're dissolved into **rainwater.**

3 or 6 - You **stay in the atmosphere** a little longer.

### Carbonate Rocks

Roll Die – What happens to you?

Roll a...

1 or 5 - The limestone you are in is weathered and you are released as $CO_2$ to the **atmosphere.**

2 - The dolostone you are in is weathered and you are washed into the **ocean.**

3 - The chalk you are in is metamorphosed by heat into marble, a **carbonate rock.**

4 or 6 - The rock you are is melted and erupts from a volcano. You are released as $CO_2$ into the **atmosphere.**

### Coal & Natural Gas

Roll Die – What happens to you?

Roll a...

1 - The coal you are in is weathered and you are released as $CO_2$ into the **atmosphere.**

2 or 5 - The coal you are in is burned and you are released as $CO_2$ to the **atmosphere.**

3 or 6 - The natural gas you are in is burned and you are released as $CO_2$ to the **atmosphere.**

4 - You stay in the **coal and natural gas** a little longer.

# Fresh Water

Roll Die – What happens to you?

Roll a...

1 or 5 - You are absorbed by **land plants**.

2 or 6 - You are absorbed by **land animals**.

3 - You are absorbed by the **soil**.

4 - You flow down a river and pass into **ocean water**.

# Marine Animals

Roll Die – What happens to you?

Roll a...

1 or 5 - The animal you are in died. Its soft parts are buried and decomposed and over many years in the rock cycle, become **oil**.

2 or 6 - The animal you are in died. Its carbonate hard parts are buried, and after many years in the rock cycle, become **carbonate rock**.

3 - The marine animal you are in is eaten by a **land animal**.

4 - You stay in the **marine animal** a little longer.

# Land Animals

Roll Die – What happens to you?

Roll a...

1 - The animal you're in dies, decomposes and you become part of the **soil**.

2 or 6 - You're breathed out as $C0_2$ into the **atmosphere**.

3 - The animal you're in is eaten by another **land animal**.

4 - The animal you're in is eaten by a **marine animal**.

5 - A tsunami washes the land animal you are in out to sea. The animal decomposes and you become part of the **ocean water**.

# Marine Plants

Roll Die – What happens to you?

Roll a...

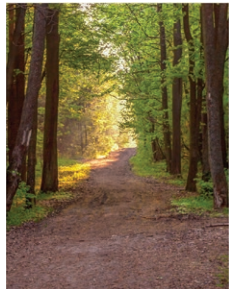
1 or 5 - The marine plant you are in is eaten by a **marine animal**.

2 or 6 - The marine plant you are in is eaten by a **land animal**.

3 - The plant you are in died. You are buried and decomposed, and after many years in the rock cycle, become **carbonate rock**.

4 - You stay in the **marine plant** a little longer.

# Land Plants



Roll Die – What happens to you?

Roll a...

1 - The plant you are in died. You decompose and become part of **soil**.

2 - You're breathed out as $C0_2$ into the **atmosphere**.

3 - The plant you're in is eaten by a **land animal**.

4 - The plant you're in is eaten by a **marine animal**.

5 - The plant you're in is burned and released as $C0_2$ into the **atmosphere**.

6 - The plant you're in is buried and compacted, and over many years in the rock cycle, becomes **coal and natural gas**.

# Ocean Water

Roll Die – What happens to you?

Roll a...

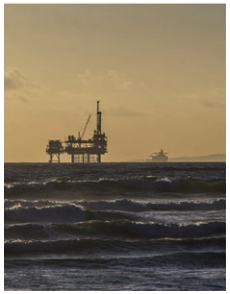
1 or 5 - You are absorbed by **marine animals**.

2 or 6 - You are absorbed by **marine plants**.

3 - You are precipitated out of the ocean water and after many years in the rock cycle, become a **carbonate rock**.

4 - You stay in the **ocean water** a little longer.

# Oil



Roll Die – What happens to you?

Roll a...

1 or 4 - The oil you are in is burned and you are released as CO2 in the **atmosphere**.

2 or 5 - The oil you are in is refined to **petrochemical products**.

3 or 6 - You stay in the **oil** a little longer.

# Soil

Roll Die – What happens to you?

Roll a...

1 or 4 - Rain falls on the soil you are in and you become part of **fresh water.**

2 or 5 - You are released as $CO_2$ to the **atmosphere.**

3 or 6 - The soil you are in is weathered and you are released as $CO_2$ into the **atmosphere.**

# Petrochemicals

Roll Die – What happens to you?

Roll a...

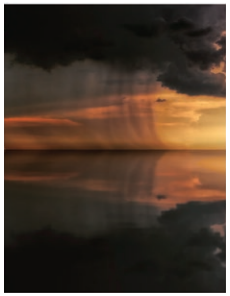
1 or 5 - The plastic bottle you are in is recycled, becoming a new **petrochemical product**.

2 or 6 - The synthetic fabric you are in is put in a landfill site, and remains the same **petrochemical product**.

3 - The rubber you are in is burned at high temperature and you are released as $CO_2$ to the **atmosphere**.

4 - The fertilizer you are in is used on a garden and you are absorbed into the **soil**.

# Rain



Roll Die – What happens to you?

Roll a...

1 or 4 - You fall into a lake or stream and become part of **fresh water**.

2 or 5 - You fall on the land and become part of the **soil**.

3 or 6 - You rain over the sea and become part of **ocean water**.

# 2.Different Volcanoes

*(Source: Mining Matters)*

SB
GP

*Volcanoes occur when molten and solid material and gases get pushed up from inside the Earth to the Earth's surface. Different volcanoes erupt in different ways and look different on the surface of the Earth. Volcanoes can also erupt with varying degrees of power, depending on how much gas has a chance to build up or release before erupting.*

***Program note:** This activity is best done outdoors.*

## Activity Purpose:

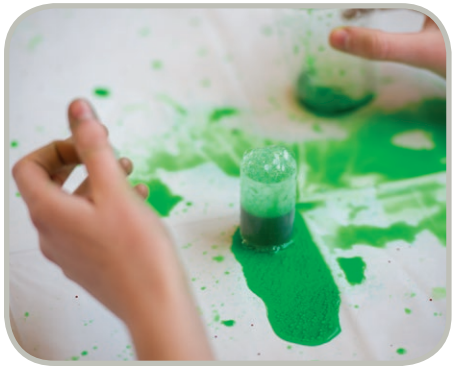
To learn and observe about two types of volcanic eruptions.

## Supplies:

- Empty hard plastic film canisters
- Vinegar
- Baking soda
- Protective eyewear
- Glitter or food colouring (optional)

## Directions:

1. Ask girls what they know about volcanoes. Explain how the activity shows how two types of volcanoes erupt. Fill two film canisters ¼ full of vinegar and place on the ground where girls can observe. Gold glitter and red, orange and yellow food colouring can be added to the vinegar to make it look like lava.
2. Fill lids of TWO film canisters with baking soda. Have girls remain five feet away to avoid the splatter zone. Wearing protective eye wear, Leader(s) empty contents of the canister lid into the first canister.
   **Do not put the lid on.** Watch as gas builds in the volcano and erupts over the edge. Leader can explain how, if the gas built up in lava is low, a volcano may not erupt violently.
3. Ask girls what they think could happen if something blocks the gas from escaping. Girls can share thoughts before the next step or demonstration.
4. Ensure girls are at least 8 – 10 feet away from the second canister. Quickly flip the lid and its contents into the canister while closing it. You will only have a second or two to do this.
5. Step back and watch what happens. Because gases had a chance to build up, the lid of the volcano will shoot off high in the air.



# 3.Water in the Ground

*(Source: Putting the Earth into Science, EdGEO)*

GPR

*Water stored under the surface of the Earth in spaces found in rocks, sediment and soil is called groundwater. The water table is the level in the ground below, at which all spaces in rock, sediment and soils are filled with groundwater. A saturated area that stores water is called an aquifer. The water in aquifers is extracted from the ground to supply drinking water. Aquifers are recharged by precipitation that enters from the surface or by water flowing underground, from outside of the aquifer.*

*Photo: Courtesy of Beth McLarty Halfkenny, Carleton University*

## Activity Purpose:

To understand how water moves through and is stored in rock, sediment and soil and how human water use affects groundwater.

## Supplies:

- Two litre clear plastic, flat-sided bottles with cap, one side cut open
- One litre plastic bottle with cap
- White gravel (garden centre/pet store)
- Drinking straw
- Bucket or dishpan
- Blue food colouring
- Masking tape
- Pump from a spray bottle (thin enough to fit into a drinking straw)
- Plastic cup
- Water
- Observation chart (provided in handbook)

## Directions:

1. Construct the aquifer model. Lay the two litre plastic, flat-sided bottle horizontally, with the cap on and the open side up.
2. Tape a drinking straw halfway along the bottle so that it protrudes vertically out of the open bottle side and rests a few centimetres above the opposite side. This represents a well.
3. Fill the bottle to 2/3 of its depth with gravel.
4. Add water, mixed with blue food colouring, up to ½ of the gravel depth.
5. Position the bucket or dishpan underneath the cap of the bottle to catch any water that flows out. This is your aquifer model.
6. Pierce a hole in the bottom of the one litre bottle. Cover the hole with masking tape.
7. Fill the bottle with blue coloured water. Replace the cap and sit the bottle upright on a paper towel. This is your supply of rain.

## Simulate normal flow, drought and flood conditions

1. Hold the rain supply above the end of the aquifer model, away from the cap.
2. Open the cap of the aquifer model and let water flow as a stream into the bucket. The bucket represents an ocean.
3. Remove the masking tape and allow rain to fall onto the gravel.
4. As needed, refill the rain supply from water collected in the bucket. Complete the Observation Chart for normal flow state.

## Drought

1. Stop any rainfall from falling onto the gravel. Keep the cap of the aquifer open. Complete the Observation Chart for drought state.

## Flood

1. Open the cap of the rain supply and rapidly pour in the water to simulate a sudden, violent rainstorm. **Complete the Observation Chart for flood state**

## Simulate and observe consumption

1. Replenish or drain the aquifer to normal flow levels, as in Part 1.
2. Keep the cap of the aquifer open to allow the stream to flow and have normal rainfall on the surface.
3. Put the stem of the pump into the drinking straw.
4. Pump out water from the well into a plastic cup. Complete the Observation Chart for water consumption.

**Geo Fact**

In a battle of the elements, water wins over rocks. Chemical and physical weathering by water and ice cause rocks to break down. These sediments can be captured and transported by wind, water or ice and deposited in a basin. Over time these sediments can be buried, cemented and lithified.

| State | Water Table Level | Well Level | Stream Flow | Sketch |
|---|---|---|---|---|
| Normal Flow | | | | |
| Drought | | | | |
| Flood | | | | |
| Water Consumption | | | | |

# 4.Glaciers and Landforms

*(Source: Putting the Earth into Science, EdGEO)*

BGP

*Throughout geological history, glaciers have changed the surface of the Earth. In some locations, this process continues at present. Manitoba most recently experienced glaciation and its effects 25,000 to 7,000 years ago.*

**Program Note:**
To provide optimum learning, invite a Manitoba geologist to help provide instruction and explanation on this activity. Contact the Manitoba Geological Survey: minesinfo@gov.mb.ca

## Activity Purpose:

To learn about landforms created by glaciation, erosion and other processes, and where some of these landforms occur in Manitoba.

## Supplies:

- Surficial Geologic Map of Manitoba and/or Google Earth®
- Geological History of Manitoba Posters: Cold Manitoba – the Quaternary
- Description of Quaternary landscape of northern or southern Manitoba and major landforms
  (Visit gov.mb.ca/iem/geo/gis/surfgeomap.html)
- Photographs of erosional and depositional landforms

## Directions:

Separate girls into small groups. Review and discuss the content in the Geological History of Manitoba Posters: Cold Manitoba – the Quaternary (Download online at ManitobaRocks.info - Teaching Resources). Distribute a set of landform photographs to each group. Describe and define the landforms. Instruct the girls to work together using their resource materials to identify the landforms in each set and separate them by process of formation. Locate examples of these landforms on a map or in Google Earth to learn about where these landforms are located in Manitoba.

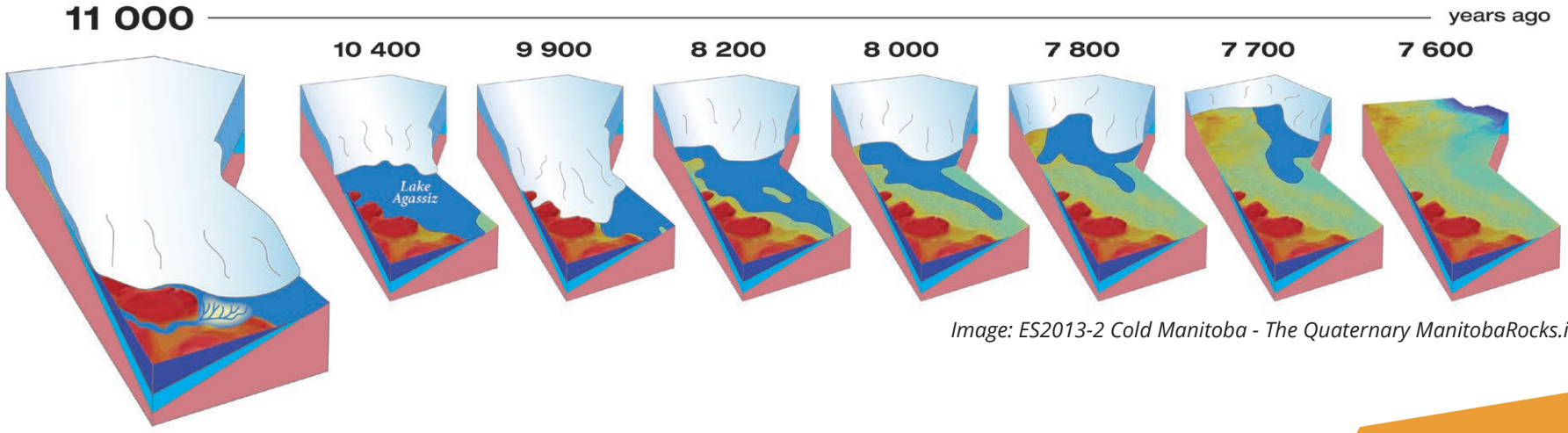
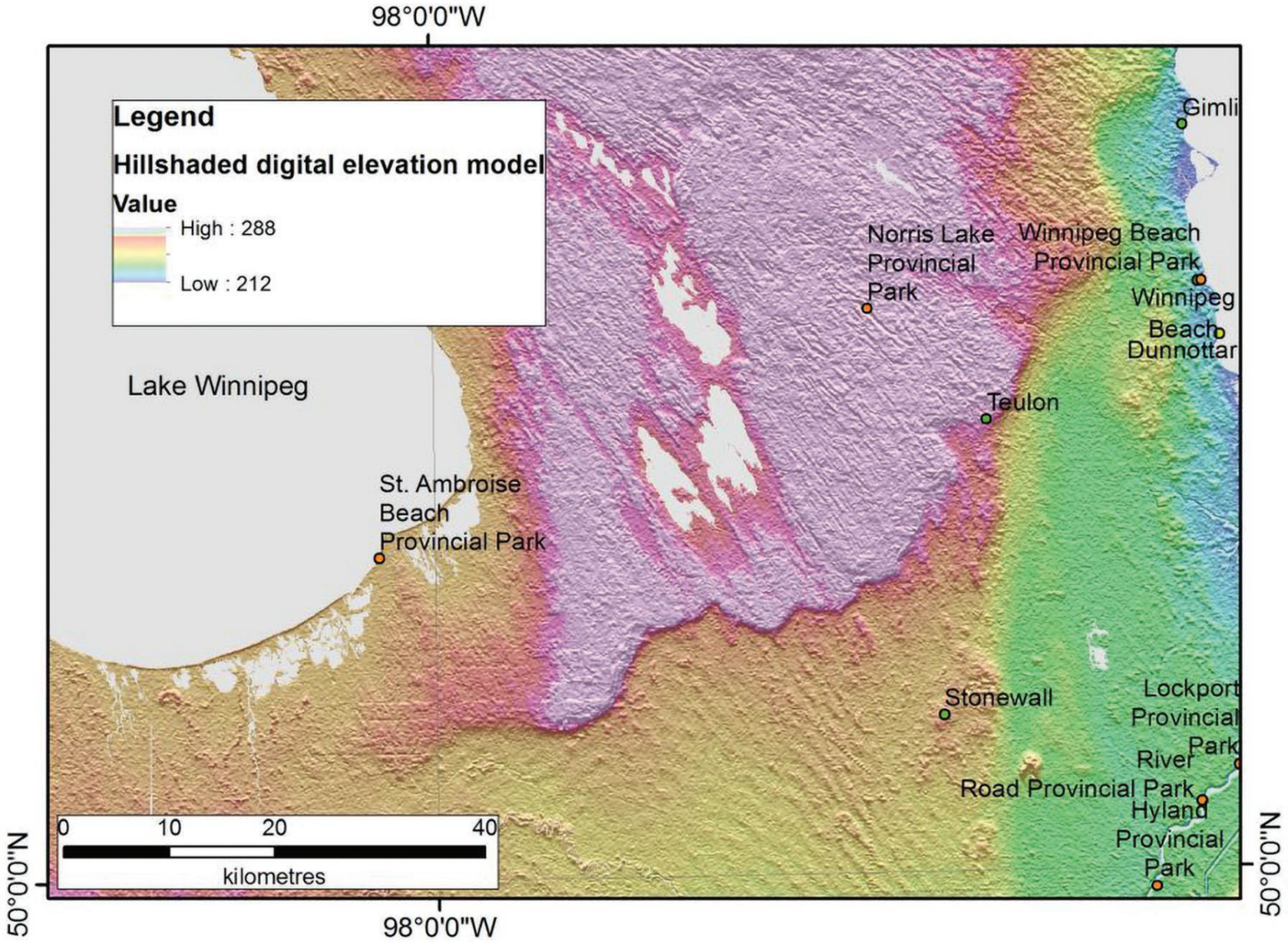
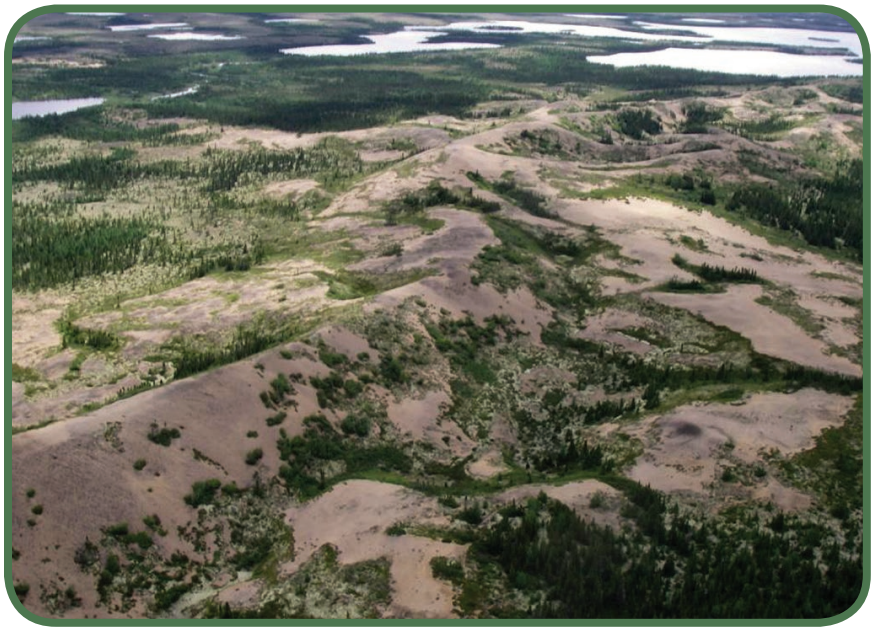



*Image: ES2013-2 Cold Manitoba - The Quaternary ManitobaRocks.info*

## Depositional Features – Manitoba



## Depositional Features – Manitoba



## Erosional Features – Manitoba

## Erosional Features – Manitoba

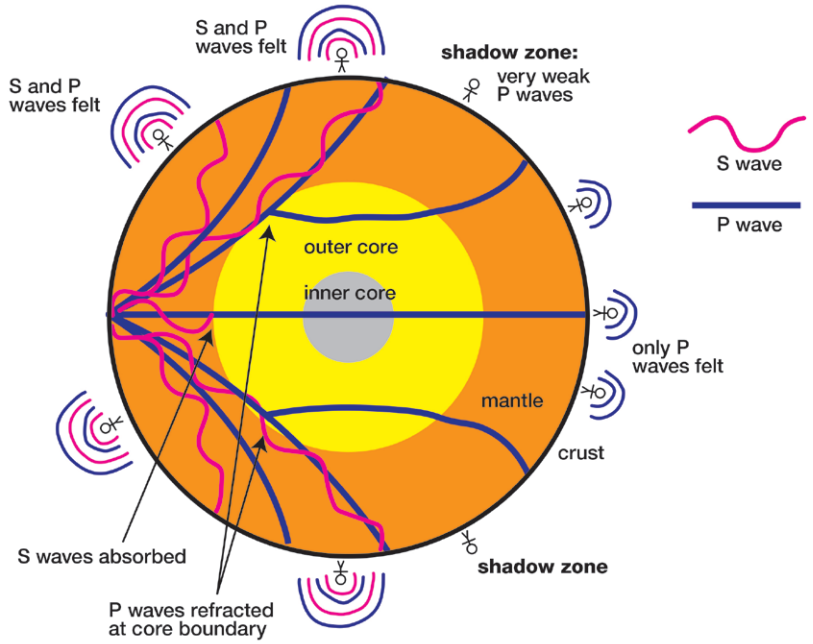
# 5.Human Earthquake

*(Source: Mining Matters)*

SBG

*Earthquakes occur when tectonic plates suddenly shift, or as a result of a volcanic eruption. The shift releases energy that makes the Earth shake. Earthquakes can vary in size and force. The magnitude of an Earthquake is measured using the Richter scale.*

***Leaders:*** *View a YouTube S waves and P waves animation youtube.com/watch?v=gl4FvHKzAlU*

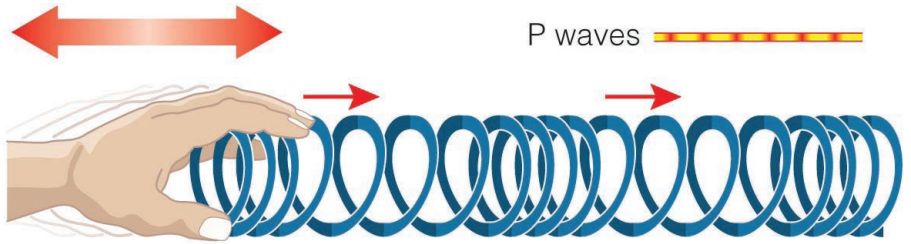



## Activity Purpose:

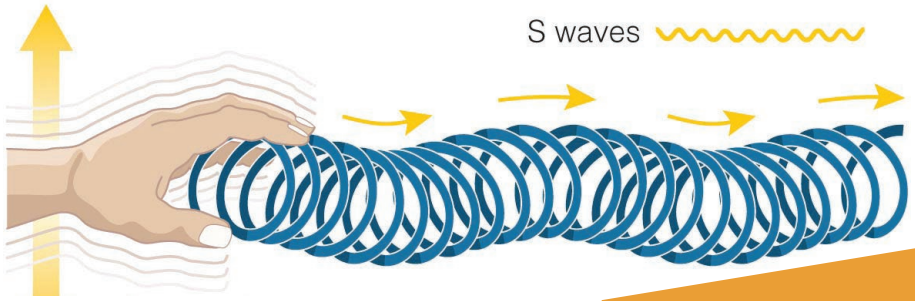
To learn the difference between two types of energy waves in the Earth during an earthquake. Leaders may try timing this activity as a race, but girls should practise the moves several times first. Before getting started, ask the girls which type of wave they think travels faster. After practising moves, go through each of the steps using the stopwatch to time how long it takes to get from one end of the line to the other end. (Primary waves travel faster than the secondary waves). The more people in line, the more pronounced the results should be.

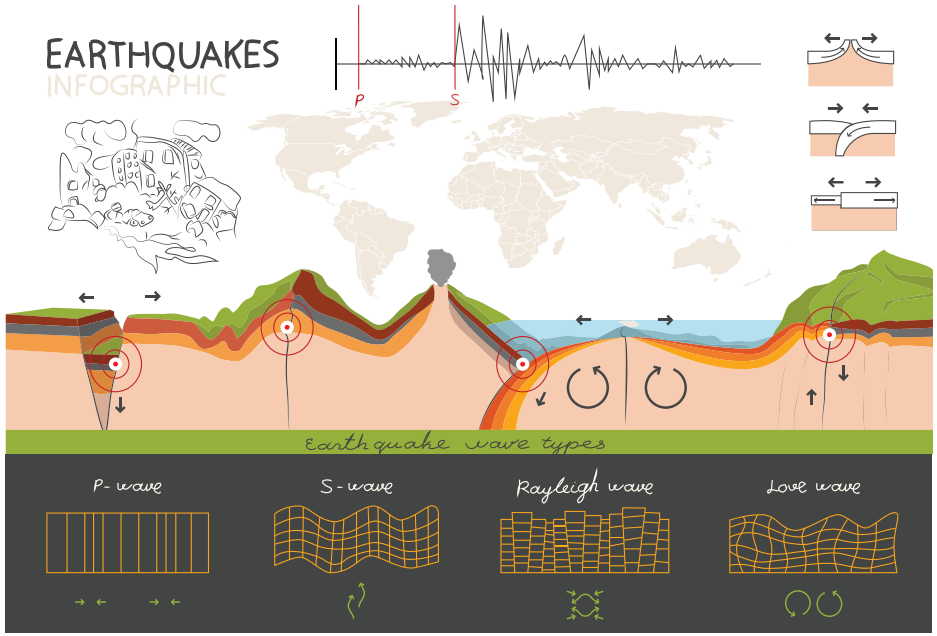
## Supplies:

- Stop watch (optional)




*P waves result from compression and stretching in the direction of travel.*






5. This will cause the girl to bump into the shoulder of a girl beside her and then straighten up. This bump will pass through the entire line of girls. **Remind girls to move only if they feel themselves being pushed or pulled.**
6. Now try the same P-wave but, this time, inform the girls that they will be **a liquid.** Girls again stand in line, close to each other with their shoulders touching, but no longer linked at the arms (results should be the same as before).
7. **Secondary waves (S-waves)** move through the ground perpendicular to the direction in which they are traveling. Girls should line up as they did in step 5 (as a solid, not liquid), but this time when the first person is nudged they **bend at the knees and then stand up.** As arms are linked, girls will be pulled up and down by their neighbours.
8. Ask girls to behave again as a liquid by unlocking their arms. With arms unlinked, **only the first person in the line will move.** (Since girls are no longer linked, there is no energy to make the rest of the girls move. This is because S-waves only travel through solids, not through liquids).

## Directions:

1. Ask girls what they know about earthquakes and what causes them, or if they know the different types of waves that occur during an earthquake: Body waves (primary and secondary) that travel through the Earth and Surface waves (Rayleigh waves and Love waves) that occur on the Earth's surface.
2. Ask girls if they know how particles in a solid and a liquid behave and inform them that they are going to simulate how energy moves through the Earth during an earthquake.
3. Instruct the girls to line up in a straight line, side by side, so that their shoulders are touching, and ask that they link arms. Tell them this is how particles in a solid behave. They are close together and linked.
4. The energy in **a primary wave (P-wave)** moves through the ground in the same direction it travels. Think of this as a **push/pull** movement. A Leader or one of the girls will start an earthquake by **gently pushing or nudging** one of the girls at the end of the line, to the side.

# 6.Folding and Faulting

BG
PR

*The Earth's surface is formed by processes such as tectonic plate movements. Folding and faulting are evidence that plate tectonics exists and that the Earth's crust is moving.*

A fold is a bend in rock due to compressional or squishing forces. Folds are most visible in layered rocks. An anticline is an arch-shaped fold. A syncline is a bowl-shaped downfold. A fault forms in rocks when stresses overcome the internal strength of the rock, resulting in a fracture. A normal fault is a fault where the hanging wall moves downward, relative to the footwall. A reverse fault is a fault along which the hanging wall has been raised relative to the footwall. A strike-slip fault is where blocks of rock slip sideways past each other. A hanging wall is the overlying side of a fault and the footwall is the mass or rock beneath a fault. Folding and faulting provide evidence for plate tectonics, the theory that the Earth's crust and upper mantle are made of more than a dozen major and minor plates that move relative to one another.
(Reference: The Dictionary of Earth, Dorling Kindersley, 1994, p. 191)


*There are major and minor plates included in the illustration*

## Directions:

### A.

**Play-Doh® Folds**

1. Review and discuss the figures in this handbook, showing folds and faults. For each group of five to six girls, create a flattened pancake of each colour of Play-Doh® (about 15 cm in diameter and one cm thick for a small or whole group activity). The greater the diameter, the thinner the layers and the more easily the model can be folded.
2. Stack layers on top of each other in any colour order to make a block.
3. Using colouring pencils that closely match the Play-Doh®, sketch the side view of this model in the space labelled (Diagram A).
4. To simulate compression (squeezing), place your hands, one on either end of the Play-Doh® block. Gently push your hands together, so that you squeeze it along its longer axis. This causes the Play-Doh® block to fold and buckle.
5. Try to make at least one upward fold (anticline) and one downward fold (syncline).
6. Using colouring pencils that closely match the Play-Doh®, sketch the side view of this model in the space labelled (Diagram B).
7. To simulate surface erosion, take your cutting device (fishing line and washers) and cut the top off of your folded model.
8. Use colouring pencils that closely match the Play-Doh®, sketch the side view of this model in the space labelled (Diagram C).
9. Discuss what you observe with your group members. When found at the surface of the Earth, repeating bands of sedimentary layers, such as in this model, tell a geologist that they have found an eroded fold.

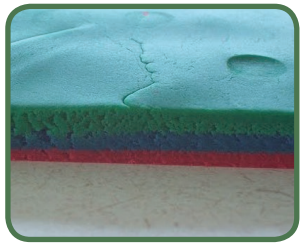


*Figure of flattened Play-Doh® layer pancake*

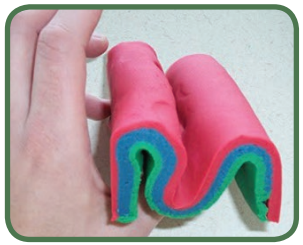


*Figure of two anticlines and a syncline*

*Source https://jazinator.blogspot.ca/2010/05/teaching-folds-using-play-doh.html*

## B.

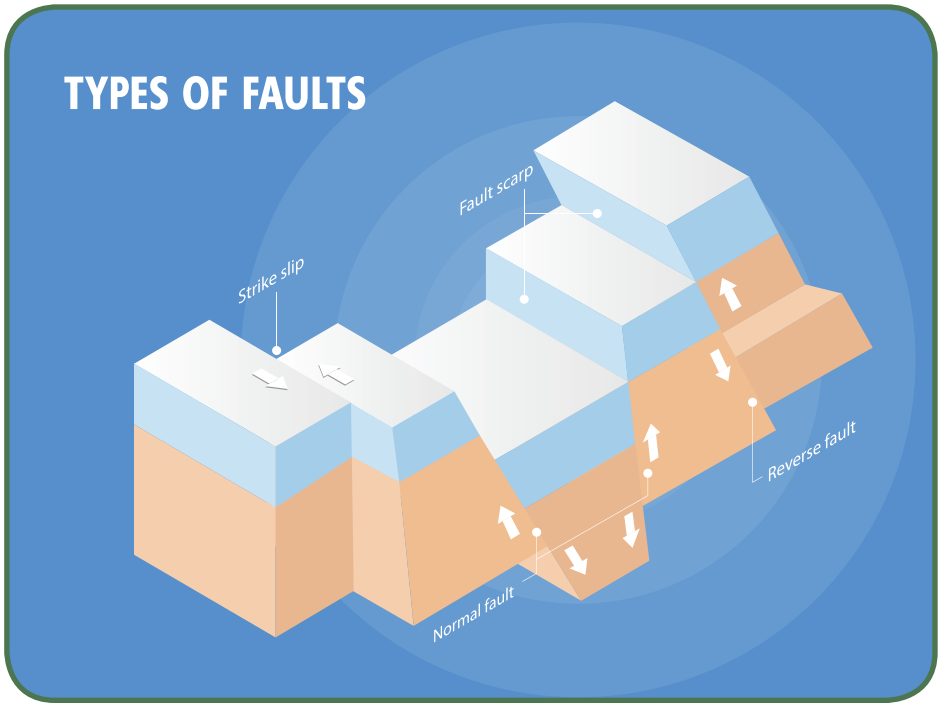
**Popsicle® Stick Faults**

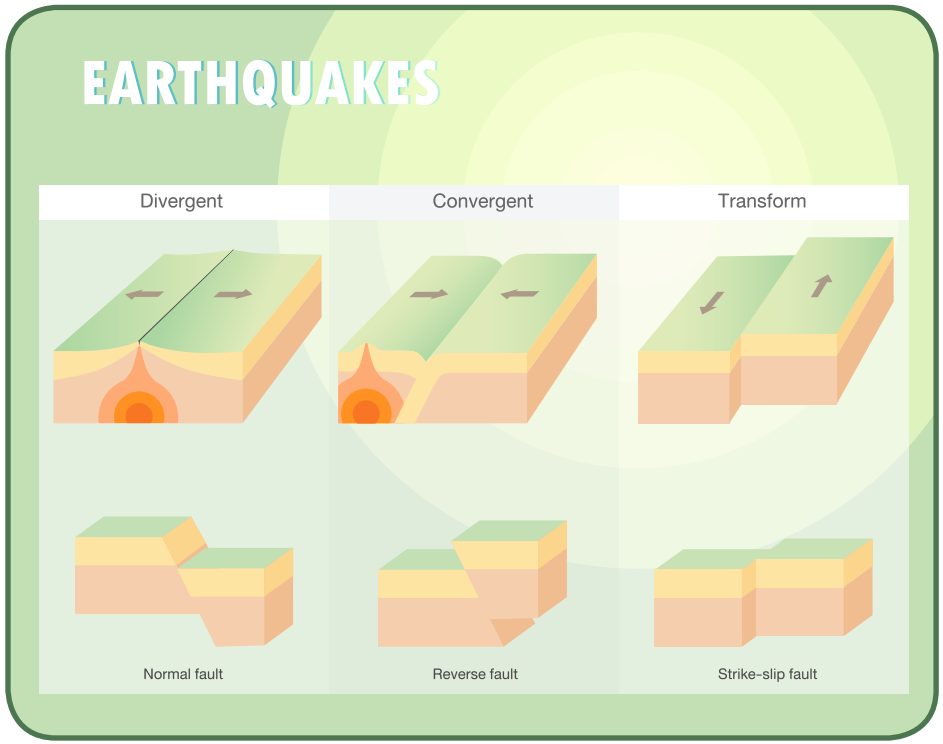
Take one Popsicle® stick. Hold it in both hands and bend it. What happens? Instead of folding, the Popsicle® stick is brittle, and breaks. This is how a fault is produced in rocks.

## C.

**Play-Doh® Faults**

Cut your Play-Doh® block model in a vertical direction – add a little bit of an angle if you like. Use this new model to demonstrate a 1) normal fault, a 2) reverse fault, and 3) a strike-slip fault. Using colouring pencils that closely match the Play-Doh®, sketch the side view of this model in the space labelled (Diagram D).




| Diagram A | Diagram B | DiagramC | Diagram D |
|---|---|---|---|
| | | | |
| **Normal Fault** | **Reverse Fault** | **Strike-Slip Fault** | |
| | | | |

# 7.What's up with Soil?

SB
GR

*Soil is made up of more than you might think.*
*Dig into soil to learn what's up with dirt.*

## Activity Purpose:

To understand that soil is primarily made up of small rock and mineral particles, plus some organic material, and that there are different types of soils, soil textures and soil characteristics.

## Supplies:

- Soil sample (This handbook recommends the use of potting soil. Potting soil can easily be mixed with fine, medium and coarse sand or small gravel to make different soil textures. It is affordable and easily sourced at a grocery store or garden centre. Soils can also be sourced from fields, forests and gardens.)
- Large glass jar
- Tube to use as siphon to remove liquid
- Spoon or spatula
- Magnifying glass
- Water

## Directions:

1. Discuss and define soil (the naturally occurring, unconsolidated mineral or organic material at least 10 cm thick, situated at the Earth's surface and capable of supporting plant growth.
2. Ask the girls if they think that a soil sample a mixture of more than one component?
3. Examine the dry soil sample under the magnifying glass. Describe its colour.
4. Describe the different particles in the soil.
   Pick up the sample, rub it between your fingers and feel its texture.
5. Record your observations.
6. Put approximately three-quarters of your soil in the glass jar and slowly add enough water to cover it. Keep one quarter dry for later comparison.
7. Watch carefully for bubbles to rise from the soil. Record your observations.
8. Fill the jar, so you have approximately half soil and half water. Add the jar lid.
9. Shake thoroughly and set aside to settle. Allow at least 20 to 30 minutes.
10. Observe carefully to determine which layers contain the largest and smallest particles. Draw and label the jar and contents after settling is completed.
11. Use the tube to draw out or siphon off all of the water being careful not to disturb the soil. **See Safety Note.***
12. Carefully remove the top layer with a spoon or spatula. Examine a small sample under the magnifying glass. Take another small sample and rub it in your fingers. Record your observations. Repeat this process for each layer. Compare the wet and dry soil samples and record your observations.
13. Ask the girls to explain their results.

**SAFETY NOTE:**
The siphon should NOT be started by sucking on the end of the tube. To correctly siphon, fill the tube completely with water. Close both ends with thumbs. Insert one end of siphon into water in the jar while holding the other end lower into a container to catch the water. Remove thumbs from the ends of the tube to start the siphon. Handle all glass jars, beakers and cylinders with care to avoid breakage.

## Principle 4:

# The Earth's people and mining are interconnected

## *How do minerals impact my daily life?*




1. A Paste with a Taste
2. Product-Matching Card Game
3. Rock Walk
4. Medicine from the Ground Up
5. Power to the People
6. Manitoba Rocks DIG IT! Minerals
7. Quarry and Pit Field Trip

# 1.A Paste with a Taste

*(Source: Mining Matters)*

SBG

*Rocks and minerals are used every day in many ways we do not think about. Minerals are in toothpaste to act as an abrasive (to help scrub our teeth clean) as well as to help strengthen and keep teeth healthy. Some minerals found in toothpaste include calcium carbonate, fluorspar (fluoride), mica, sand (silica) and titanium.*

*Source: http://skywalker.cochise.edu/wellerr/students/toothpaste/project.htm*

## Activity Purpose:

To explore how rocks and minerals are used in toothpaste.

## Supplies:

- Baking soda
- Calcium carbonate (unflavoured TUMS®)
- Mortar and pestle
- Water
- Small cups
- Eye dropper
- Measuring spoons
- Stir stick
- Food colouring
- *Optional:* Food flavouring (peppermint, cinnamon, almond, orange)

## Directions:

1. Ask girls what they think they brush their teeth with when using toothpaste? *(Answer: rocks or minerals)*
2. Grind TUMS® into a fine powder with mortar and pestle.
3. Provide girls with a basic recipe for toothpaste:
   ½ teaspoon calcium carbonate (TUMS®)
   ¼ teaspoon sodium bicarbonate (baking soda)
   Enough water to make a paste
4. Give girls a few minutes to make their toothpaste by mixing ingredients. Ask why they think "their" toothpaste doesn't taste like what they use at home. Emphasize that many of the ingredients in toothpaste are minerals. **(OPTIONAL)** Once girls offer suggestions to make their recipe taste better, let them try altering their recipes with extra ingredients (e.g., flavourings).
5. Have a toothpaste taste test competition and let girls decide which recipe tastes best.

# 2.Product Matching Card Game

BG

*(Source: Mining Matters)*

*This card game challenges girls to find and match everyday items with the rocks or minerals of which they are made. Half of the cards have the name of a rock or mineral and a description of some of the ways the rock or mineral is used. The other half has a picture of an item made from rocks or minerals. The directions are for a memory game. However, for younger girls, this can be simplified so that all of the cards can be seen.*

## Activity Purpose:

To explore ways people use rocks and minerals every day.

## Supplies:

- "What's Your Is Mined" product matching cards (contact minesinfo@gov.mb.ca for this card game)

## Directions:

1. For each group, choose the number of matching pairs that you would like to use for the game. Print one copy of each. While each rock or mineral may have many uses, the correct match for the purpose of the game will be **bolded.**
2. Split girls into small groups (this game usually works best with groups of three to six)
3. Spread the cards out face down, in a grid pattern.
4. Chose one girl to go first. She will turn over two cards and read out loud the information they contain or identify the item they list (younger girls may require assistance). If the cards match, the girl gets to keep them and take another turn. If the cards do not match, she will turn them back over, where they were originally located and the next girl takes her turn.
5. Play continues until all cards have been matched. The winner of the game is the girl with the most matches.
6. The difficulty of the game can be increased by the number of matches in a game.

# 3.Rock Walk

SG
BPR

*(Source: Mining Matters)*

*Rocks and minerals are used all around us, including the inside walls and outside walls of buildings, windows, roofs, fences, roads, sidewalks, benches, railings, street lights and signs. Take a look around the building where your meetings are held. Where do you see mined materials?*

**Tip:**
Leaders may also want to use the Out of the Ground, Into Our Daily Lives poster, from the U.S. Geological Survey, for added discussion about rocks and minerals: https://pubs.usgs.gov/of/2001/0360/pdf/of01-360.pdf

**Geo Fact:**
Did you eat your rocks today? We all need minerals from the Earth to stay alive and healthy. We can get minerals from plants grown in the ground, or manufactured as vitamins. Major essential minerals or macro minerals we need include: sodium, chloride, potassium, calcium, phosphorus, magnesium and sulphur.

## Activity Purpose:

To explore ways rocks and minerals are used.

## Supplies:

- Leader's Checklist/Guide
- Notepad, pencil or pen to record findings

## Directions:

Discuss with the girls some of the ways rocks and minerals are used every day. Explain that you are going to go on a quick walk around the building or neighbourhood to look for different ways rocks and minerals are used. Begin walking. As girls find or source new items to record, give them a few minutes to discuss and record before moving on. The walk can be as long or as short as you like.

| | Object | Rock, Mineral or Metal Used | | Object | Rock, Mineral or Metal Used |
|---|---|---|---|---|---|
| | **Play Equipment** | | | **Parking Lot** | |
| ☐ | Slides | Iron, Aluminum | ☐ | Asphalt | Crude Petroleum, Sand, Gravel, Crushed Stone |
| ☐ | Metal Swings | Iron, Aluminum | ☐ | Street Lamps | Limestone, Gypsum, Iron, Aluminum, Copper, Quartz |
| ☐ | Ladders | Iron, Aluminum | ☐ | Cars | Iron, Copper, Aluminum, Lead, Nickel, Sand, Silicon, Sulfur, Zinc |
| ☐ | Play Structures | Iron, Aluminum, Limestone, Gypsum, Clay | ☐ | Bicycle Racks | Iron, Aluminum |
| ☐ | Benches | Limestone, Gypsum, Iron Oxide, Clay | ☐ | Bicycles | Iron, Aluminum |
| ☐ | Basketball Hoops | Iron, Aluminum | ☐ | Garbage Cans | Iron, Aluminum |
| ☐ | Flag Poles | Iron, Aluminum | ☐ | Water Drain Grates | Iron, Aluminum |
| | | | ☐ | Sign/Traffic Signs | Iron, Aluminum |
| | | | ☐ | Electrical Wires | Iron, Aluminum, Copper |

| | Object | Rock, Mineral or Metal Used | | Object | Rock, Mineral or Metal Used |
|---|---|---|---|---|---|
| | **Building** | | | **Yard** | |
| ☐ | Concrete | Limestone, Gypsum, Iron Oxide, Clay, Dolostone, Sand, Gravel | ☐ | Artificial Grass | Barite, Petroleum products |
| ☐ | Bricks | Clay, Shale | ☐ | Metal Fencing | Iron, Aluminum |
| ☐ | Paint | Titanium Dioxide, Wollastonite, Sand | ☐ | Sandboxes | Sand |
| ☐ | Screws and Hinges | Copper, Iron, Zinc | ☐ | Railings, Posts | Iron, Aluminum |
| ☐ | Window Glass | Quartz, Limestone | ☐ | Fencing | Iron, Aluminum |
| ☐ | Steel Roofing | Iron, Limestone | ☐ | Landscaping Rocks | Natural Rock, Limestone, |
| ☐ | Metal Flashing | Iron, Aluminum | ☐ | Gravel | Natural Gravel, Crushed Stone |
| ☐ | Eavestroughs | Iron, Aluminum | ☐ | Sand | Natural Sand |
| ☐ | Roof Shingles | Sand, Gravel, Crushed Stone, Petroleum | | | |

# 4.Medicine from the Ground Up

*(Source: Mining Matters – Mining Makes it Happen)*

GP

## Activity Purpose:

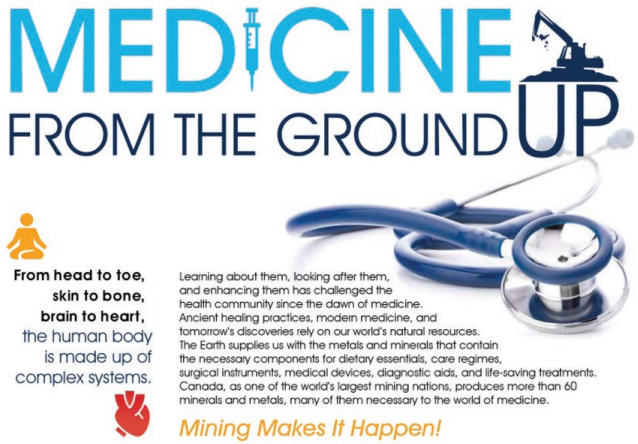
To learn about elements and the role they play in health and medicine.

## Supplies:

- Internet access
- Download the Medicine From the Ground Up poster at: ManitobaRocks.info (Teaching Resources)
- Download a periodic table of elements ptable.com

## Directions:

Girls review the entire contents of the poster. Leader(s) instruct girls to select and research <u>three</u> of the featured elements, including whether they are mined in Manitoba. To review what's mined in Manitoba, have girls explore the ManitobaRocks.info website and report their findings back to their group.




# 5.Power to the People

*(Source: Mining Matters – Mining Makes it Happen)*

GP

## Activity Purpose:

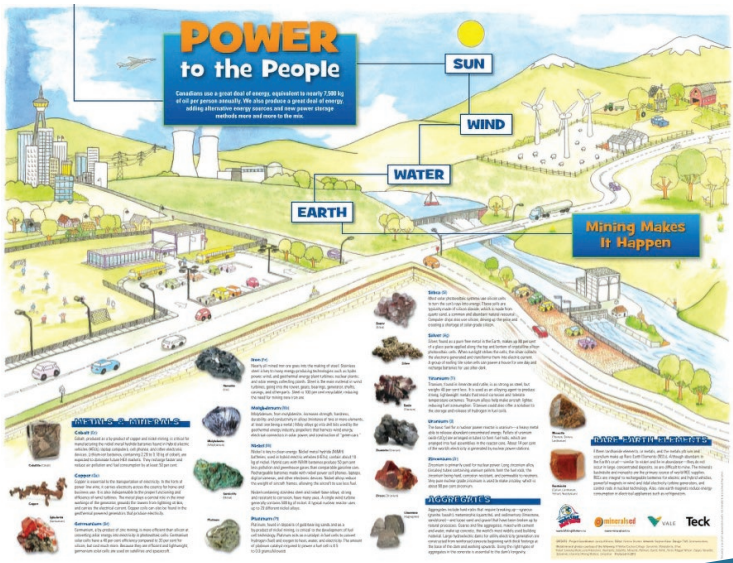
To understand the role energy plays in our daily lives, the types of energy, and the types of energy-related jobs.

## Supplies:

- Internet access
- Download Power to the People poster at ManitobaRocks.info (Teaching Resources)

## Directions:

Review entire contents of the poster. Instruct girls to select and research an energy type, an element and a career. Have girls report back to the group and share why they chose to research the energy type they did.



# 6.Manitoba Rocks DIG IT! Mineral Card Collection

BG

*Discover what on Earth is under your feet in Manitoba, using a geology card deck.*


## Purpose of the activity:

To play the ***Dig It!*** game and learn about the elements, minerals, rocks and fossils of Manitoba.

## Supplies:

- ***Dig It!*** Cards (contact: minesinfo@gov.mb.ca; for extra info, visit the Dig It! Page at ManitobaRocks.info

## Directions:

Follow the instructions included in the deck of cards. The goal of the game is to get as many Mohs Scale points as possible. The game can be played one-on-one, or in pairs or small groups. The Mohs' hardness scale was developed in 1822 by Frederich Mohs and is a chart which defines the relative hardness of various minerals (1 - softest to 10 - hardest).

# 7.Quarry and Pit Field Trip

GPR

## Activity Purpose:

To learn about different types of aggregates and about rock quarries and sand and gravel pits, including operations and site rehabilitation.

## Supplies/Project Note:

This activity requires parental support and planning. Girls will usually require hard hats and steel toe footwear at an operating quarry site. For safety reasons and private property regulations, it is important not to visit a quarry without permission. Many quarries in Manitoba do not allow public access. This handbook recommends a visit to Stonewall Quarry Park Interpretive Centre (See StonewallQuarryPark.ca). Rural and northern areas may contact local quarry companies to inquire about access to sites.

## Directions:

1. Check with local aggregate companies about visiting a quarry or gravel pit near you.
2. If possible, tour the local site and explore and discuss aspects of geology, blasting, excavation, crushing, environmental management and rehabilitation.
   *(Optional)* Review a geological map to learn about locations of other quarries and pits in the province and the types of deposits that are extracted (Contact minesinfo@gov.mb.ca).

## Principle 5:

# The Earth's mineral resources require our care

## *How do humans impact the Earth?*


1. Recycle, Reduce, Reuse Relays
2. Indigenous Earth Ideas
3. Operating a Surface Mine
4. Upcycle Lanterns
5. Manitoba by Satellite
6. Recycle your Mobile Phone
7. Reclamation and Rehabilitation

# 1.Recycle, Reduce, Reuse Relays

*(Source: Mining Matters)*

SBG

*Guides sort everyday items by stream, according to the elements, minerals and metals that are used to create them.*

## Activity Purpose:

To learn how manufactured items can be recycled and how mined materials are used to manufacture items that we use daily. (**Program Note:** To make this more fun or challenging, Leaders can time the action to be completed in five minutes. Leaders may also find Reduce, Reuse, Recycle posters describing local regulations online to prepare and share during the activity).

## Supplies:

- Two sets of bins marked "Reduce, Reuse, Recycle and Landfill"
- A collection of manufactured items (housewares, electronics, clothing, etc.), for the waste stream

**Leaders:** Have girls bring in items they no longer need so they can do the activity with items that are relevant to their daily lives.

## Directions:

1. Divide girls into two teams and divide the collection of items into two piles.
2. Set up a start line, with girls/teams at the line and bins set up approximately 50 feet away. Instruct team members to each select an item from their collection and race to the bins, placing the item in the correct bin, then racing back to starting line. The next person in line does the same, until all items are in bins. The team to complete sorting of their items first is deemed the winner.
3. Review the contents of each bin to ensure that the items have been sorted properly.
4. Have girls discuss the value and importance of recycling, reusing and reducing.

# 2.Indigenous Earth Ideas

SBG

*Learn about Indigenous peoples' perspectives on natural resources and resource protection. Visit the ManitobaRocks.Info – Directions website page.*

## Activity Purpose:

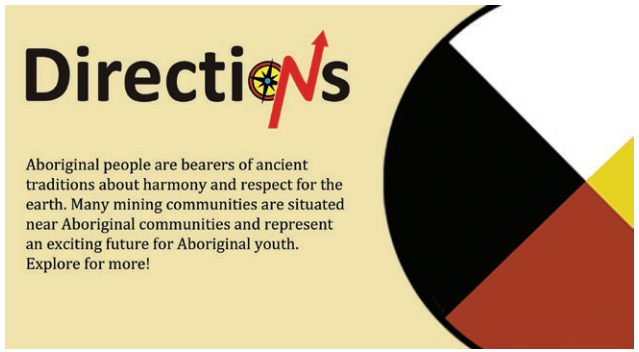
To learn about the perspectives of Indigenous peoples of Manitoba regarding land use and mineral resources.

## Supplies:

- Notebook and pen to record responses
- (Optional) Smartphone to record interview

## Directions:

1. **Leaders:** Contact Elders or Knowledge Keepers in local communities to ask if they would consider being interviewed individually or if they would attend a Guide meeting.
2. Have girls prepare questions to share with Elders or Knowledge Keepers before the interview or meeting, so they can be prepared. For example: What do Indigenous people call North America and why? Are rocks always called grandfathers by Indigenous people, and if so, why?
3. Leaders can ask girls to share what they learned with their friends and family in a report.



# 3.Operating a Surface Mine

SBG

*(Source: Mining Matters)*

*Mining is one of the ways people alter the Earth. In order to have the necessary materials to make the items we use, minerals and metals are mined from the ground. One way of getting minerals from the ground is through a surface mine (if the desired material is near the surface, rather than deep underground). Minerals must be extracted from the host rock. Girls can decide how they will make their own mine work and what their renewal or reclamation plan will be for closing a mine after minerals are extracted. A reclamation plan (how to transform the mine site into usable land) is decided on before any mining can begin. (Program Note: Leaders can prepare for activity at: ManitobaRocks.info (see Teens Rock, Exploration and Mining, Green Mining video).*

**Project Note:**
This activity can be completed in 15-20 minutes. Consider splitting the activity into two separate meetings, one where the models are made and discussed, and one where the models are mined and reclaimed.

## Activity Purpose:

To encourage girls to think about what is involved in extracting minerals and materials that are needed in everyday items, from the Earth.

## Supplies:

- Clear sandwich Tupperware® dish
- Uncooked rice, dry beans
- Brown construction paper
- Green construction paper
- Tweezers and/or small spoons
- (Optional) Small tree, animals

## Directions:

1. Split girls into groups of three to six.
2. Ask group members to create a mine by filling their container almost to the top with a mix of about ¾ uncooked rice (host rock) and about ¼ dried beans.
3. Place a piece of brown construction paper over the rice and bean mixture.
4. Place a piece of green construction paper over this. Add trees and animals if desired.
5. Have girls decide how they will mine the beans and what they are going to do with the trees, grass and soil that must be removed.
6. Have girls decide on a reclamation plan; what will they do with their land once they have finished mining and how it will be reused.
7. Share the results of both the mining and reclaiming or renewing of the land. Girls may discuss why reclaiming the land after mining is so important.


# 4.Upcycle Lanterns

*(Source: Mining Matters)*

GPR

*Everything we use is made from the Earth's resources, many from rocks and minerals. These items can be reused or upcycled to make new items. Once completed, this creative and fun craft can be used to decorate an outdoor or indoor space.*

## Activity Purpose:

To explore new ways to use items once the contents have been used up.

## Supplies:

- Clean, empty soup or vegetable can (experiment with different sizes)
- Rectangular, blank piece of paper (same size as outside of can)
- Nails (different diameters or sizes)
- Tea light candle (or battery-operated tea light candle)
- Hammer
- Tape
- Wire hanger

### Directions:

1. Remove labels from the outside of the can and ensure that the inside of can is clean. Leaders may prepare cans in advance or have girls collect and bring in clean cans from home.
2. Have girls cut pieces of paper to match the size of the can/lantern they are working with. The paper will be used to design the lantern. Girls draw small circles on paper where they want to poke holes in the can for their design. The more holes, the more light shines through the lantern, but be sure to leave enough blank space to hold the can together - too many holes can cause the can to collapse.
3. Once a design is planned on paper, have girls wrap the paper around the can as a guide. Paper can be taped to the can, but should be taped so that the open end is at the top and the solid end of the can is the bottom.
4. Carefully use assorted nails and the hammer to make holes, following the plan. **Be careful, the inside of can will be sharp where holes are punched.**
5. Punch two holes near the top of the can, directly across from each other. These will be used to attach a handle.
6. Straighten the wire hanger. Thread one end of the unbent hanger into one of the holes for the handle. Bring it up around the top of the can and twist it in place. Do the same with the other end of the hanger and the other hole.
7. Place a tea light candle in the bottom of the lantern. When the candle is lit, the light will come through the holes. Note: Battery-operated tea lights may also be used for safety purposes.

# 5.Manitoba by Satellite

GPR

*Use Google Earth® to navigate Manitoba. Identify elements of the natural environment and built (towns, cities) environment. Locate areas of past and present mining and aggregate activity.*
*google.ca/earth*

### Supplies:

- Google Earth® (Desktop or Mobile App)

### Directions:

Instruct girls to use Google Earth® to locate regions and geographic locations where mining or aggregate extraction takes place (Thompson, Flin Flon, Snow Lake, Lynn Lake, Bissett, Garson, etc.). Also, have girls locate major cities and towns (Winnipeg, Brandon, etc.)

# 6.Recycle your Mobile Phone

GP

*(Source: EarthLearningIdea.com)*

## Activity Purpose:

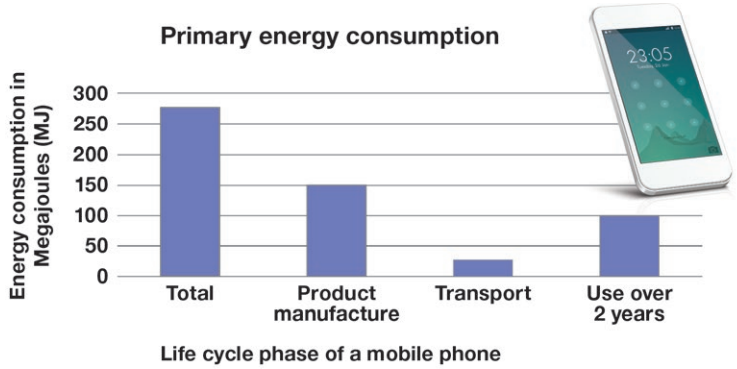
To help Guides to understand consumer choices and technology. This activity prompts girls to consider materials and energy used to both manufacture and use a mobile phone, and why it's important to think about what happens to a phone when it is replaced or no longer used.

## Supplies:

- Recycle Your Mobile Phone Activity Information
- Energy Consumption (graph - provided)

## Directions:

1. Create a diagram illustrating The Life Cycle of a Mobile Phone.
2. Plot on a world map the countries where phone components come from.
3. Discuss issues associated with burying a broken mobile phone in a landfill (i.e. heavy metals, etc., leaching into ground water). Discuss the impact of a mobile phone's life on greenhouse gases from the use of energy at all stages of its use.




## Recycle Your Mobile Phone Information
## Stages in the life of a mobile phone:

**Minerals and Metals**

Mobile phones contain between 500 and 1,000 components. 40 per cent of the phone is made of metals; 40 per cent of plastics and fibreglass and 20 per cent of ceramics and trace materials. The metals and trace materials include: copper, gold, lead, nickel, zinc, beryllium, coltan (columbite-tantalite), antimony, arsenic, tin and silver. Plastics are made from oil; fibreglass from sand and limestone. The liquid crystal display (LCD) may include small amounts of metals like mercury. The rechargeable battery may contain nickel, cadmium, cobalt, zinc, copper, lead or lithium.
Some of the materials that are used in the manufacture of phones are mined in countries that are affected by conflict. Health and safety and environmental protection practices can vary among countries. Energy is required to operate machinery to mine the materials from the ground and to transport them to ports and airports.

**Manufacturing**

Phone manufacturing involves a global supply chain. The raw materials are made into mobile phone components in many different countries. For example, one manufacturer obtains its components from at least 29 countries, located all over the world, including Austria, Brazil, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Israel, Japan, Korea, Malaysia, Mexico, Morocco, Netherlands, Philippines, Portugal, Singapore, Slovakia, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom and the United States. Energy is needed to operate the factories and to transport the components to the places where they are assembled into a finished mobile phone.

**Packaging and Transport**

Mobile phones are packaged to protect them from damage and to attract buyers. Packaging is made from paper or cardboard (made from trees), plastics (from oil), and other materials. Energy is needed by the packaging factory and in transporting the finished product to the shops.

**Phone Use**

The urge to frequently change brands or upgrade models may mean that a discarded phone ends up in a landfill.

# 7.Reclamation and Rehabilitation

GPR

*Mining is a temporary use of the land. No mine operation lasts forever. It is an important goal of mining or aggregate companies to return the site they've mined to its natural state, making it available for other uses. When a mine, quarry or pit is closed, the site needs to be restored to a useable condition or changed to another use or state that complements the surrounding landscape.*

## Program Note:

Girls will benefit from having completed Principle 5, Activity 3 prior to doing this activity. Leaders may prepare by reviewing Orphaned/Abandoned Mine Site Rehabilitation in Manitoba or additional photos and information at Manitoba's Pit and Quarry Rehabilitation Program:
gov.mb.ca/iem/mines/oa_rehabilitation.html
gov.mb.ca/iem/mines/sustain/quarry.html

## Activity Purpose:

To understand how mining or extracting minerals from the Earth are a temporary use of land and how reclamation or rehabilitation must be planned for before any mine, quarry or pit is permitted to operate.

## Supplies:

- Before and after land reclamation photos (provided)

## Directions:

1. Examine before and after photos to learn tasks that happen when mining operations are closed.
2. Locate the mine, quarry or sand and gravel pit closest to where you live. Think about how you would either rehabilitate or reclaim the site and the land when the resource being mined or extracted has become depleted and the site closes.
3. Prepare a presentation and explain: a. What the area will be used for (e.g., golf course, community park, bird sanctuary, botanical garden). b. What steps you will take in your rehabilitation or reclamation project (e.g., filling in the area with soil to create hills for a golf course or leveling off the area in order to build a school or shopping mall). c. What resources you will need and how they will be used (e.g., topsoil, trees, plants, sand and gravel for roads).
4. Prepare before and after diagrams, one that shows how the area looks before and how it will look after reclamation. Your presentation may be a report, poster, slideshow or speech with visuals.

## Manitoba Sand and Gravel Pit Rehabilitation Projects

### Before

*Pit rehabilitation project, located near Falcon Lake*

*Sand/gravel pit before rehabilitation, south of Steinbach*

### After

*Pit slope and floor reshaped, near Falcon Lake*

*Same sand/gravel pit reshaped, with new vegetation*

## Principle 6:

# The Earth has way mORE to explore!

## *Explore the Earth by thinking like a geoscientist!*



1. Cookie Mining
2. WHERE Challenge!
3. Field Data Collection
4. What do Paleontologists do?
5. Go on a GeoTour in Manitoba
6. Get to Know a Geoscientist

# 1.Cookie Mining

BG
PR

## Activity Purpose:

To introduce basic cost management related to mining and the importance and cost of reclamation or of restoring land to its natural state after the land has been mined. Girls can work in groups of three to four and are buyers who purchase property, mining equipment and also pay for a mining lease and the costs associated with operation and reclamation. In return, each team receives money for ore mined (chocolate chips recovered). The goal is for girls to aim to develop a mine as efficiently as possible, to safeguard the environment while mining, and to make as much money as possible from the valuable ore extracted.

## Directions:

Girls can use their fingers to hold the cookie, but must use their "tools" to mine. A team can purchase as many mining tools as desired. Tools can be different types. If the mining tools break, they are no longer usable and a new tool must be purchased. The team that makes the most money by the end of the mining exercise wins a prize (to be determined by Guide leader).

## Materials:

- Play money ($25 per team)
- Grid paper (one sheet per team – see sample provided)
- Two types of chocolate chip cookies (one per team) (jumbo, regular and rainbow chips (for polymetallic ores)
- Toothpicks (flat and round)
- Paper clips (large metal or plastic-coated clips)

## Special Instructions:

1. Each team starts with $25 of play money. One girl manages expenses and keeps time of the mining process and how long it takes to extract the chips.
2. Teams each receive a Cookie Mining Sheet and grid paper.
3. Girls on each team buy the mining property, which is ONE chocolate chip cookie. At least two types of cookies should be for sale: one is less costly (has fewer and smaller chocolate chips); the other is more costly (larger chips).
4. After buying the team cookie, girls in each team place the cookie on grid paper and using a pencil, trace the outline of the cookie.
5. Each team must also buy mining equipment. More than one piece of equipment may be purchased. Equipment may not be shared between teams.

Mining equipment for sale:

| | |
|---|---|
| Flat toothpick | $2 each |
| Round toothpick | $4 each |
| Jumbo metal paperclip | $6 each |

6. Mining costs $1 per minute (Remember: This should be recorded by the girl on the team who is managing the expenses, along with all other purchases).
7. Mining money earned: $1 per chocolate chip (broken chocolate chips can be combined to make one whole chip).
8. Once the whole cookie is mined, cookie crumbs and pieces must be placed back into the circled area on the grid paper using mining tools only - no fingers or hands allowed.
9. Mining costs (expenses): $1 per square (to place cookie pieces back inside the grid) Pieces of cookie left outside of the circle must also be counted as reclamation costs at $1 per piece.
10. Team Leaders – each complete the Cookie Mining Cost Sheet

**Tip:**

Ask girls what they think the cost would be if they were working with thousands or millions of dollars instead of $25

## COOKIE MINING COST SHEET

**1.** Type of Cookie _____
Price of Cookie $_____

**2.** . Equipment used
Flat toothpick _____ x $2 = _____
Round Toothpick _____ x $4 = _____
Paper Clip _____ x $6 = _____

**3.** Mining _____ minutes to complete x $1

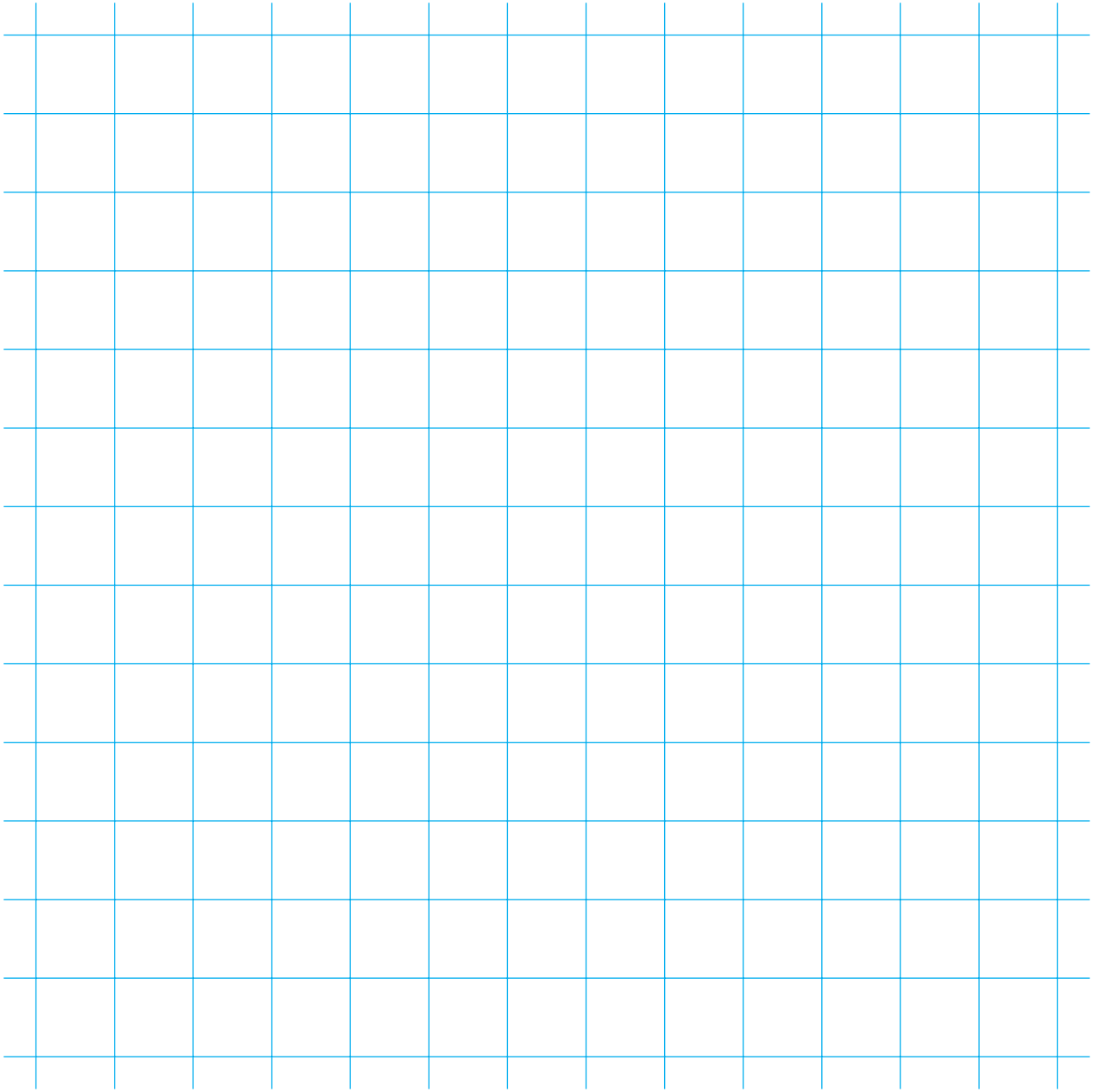
**4.** TOTAL COST OF MINING (ADD: Above items)
$_____

**5.** . TOTAL VALUE OF CHIPS
(number of chips removed (mined)_____ x $1)
$_____

**6.** RECLAMATION FEE
(reclamation: _____ grid squares x $1
+ extra crumbs x $1)
$_____

## HOW MUCH DID WE MAKE?

| | |
|---|---|
| BUDGET | $25 |
| TOTAL VALUE OF CHIPS | + $_____<br>= $_____ (Total 1) |
| TOTAL COST OF MINING | - $_____<br>= $_____ (Total 2) |
| RECLAMATION FEE | - $_____<br>= $_____ (Total 3)<br>Profit (+) or Loss (-) |
| Total 3<br>INITIAL BUDGET | $_____<br>- $25<br>= $_____ Profit (+) or Loss (-) |



The traced area of your cookie is your mining lease. Make sure you keep all of your mining activities inside this space; otherwise you will receive a fine of $1 per extra piece or crumb.

**NAME YOUR MINE:** _____ **TOTAL CHOCOLATE CHIPS MINED:**_____

# 2. WHERE Challenge

GP

*The WHERE Challenge is a fun and exciting national contest that asks 9-14 year-olds two key questions:*
*What on Earth is in your stuff?*
*Where does it come from?*

WHERE challenge
Sponsored by Teck

## Activity Purpose:

To learn where non-renewable resources come from and the role they play in our daily lives.

## Directions:

1. Allow girls the opportunity to explore the WHERE Challenge website at Earth Science Canada: http://earthsciencescanada.com/where/. All rules and expectations for the contest and examples of previous winners are available to review.
2. Ask girls individually, or in a small group pick an item to focus the project on. Find out what non-renewable resources are in the item you've chosen, and where in Canada and the world they are mined.
3. Have girls plan a creative project (a poem, story, song, poster, comic, movie or any other creative format), following one of the rubrics on the contest website to respond to the questions.
4. WHERE runs from September and March each year. Submit girls' entries during this time frame for a chance to win great prizes.

# 3. Field Data Collection

GPR

*Collect and analyse information ...like a geoscientist.*

## Purpose of the activity:

This activity is intended to provide Guides with a glimpse into a day in the life of a geoscientist and to provide an experiential learning opportunity. This is an activity to be undertaken over the course of a couple of meetings. This activity can take place at a park, playground, school yard, etc.

## Supplies:

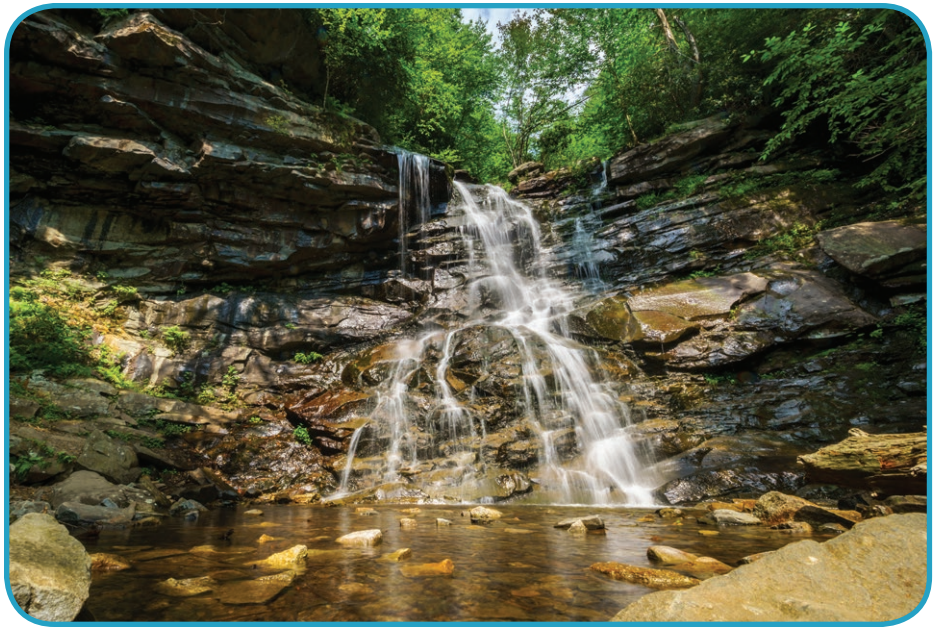
- Smartphone camera
- Handheld GPS
- Compass (optional)
- Map of Manitoba
- Notebook
- Sample bags

## Directions:

At the first meeting for the activity, choose a field location near the meeting site or wherever the Leader knows there is potential geological interest (e.g., a park, hiking or biking trail, a field with rocks and boulders, and a rock or sediment area). If you meet in an urban area, a local school playground is ideal. In Winnipeg, Oodenna Celebration Circle at the historic area of The Forks is a unique site.
Separate girls into pairs or teams of four. Upon arriving at field site, ask girls to work together to locate and record the location on their map. If girls wish, they can also record the location using GPS coordinates.
Once girls are orientated in an area, have them explore to see what geological traits might be there. Ask girls to draw a rough sketch of the site, take photographs, and/or make notes of landscape and features throughout the site. This is how to collect field data.

After girls complete collecting data, they can learn more about the site with extra research (e.g., conducting a web search).

**Leaders:** For optimum learning, invite a Manitoba geologist to help provide instruction and explanation on this activity. Email the Manitoba Geological Survey at: 204-945-1119 or at: minesinfo@gov.mb.ca or contact the Mineral Society of Manitoba.



## Extension Activity:
## Build a Magnetic Field Detector

### Materials:

- Drinking straw, two steel pins
- Tape, thread and a bar magnet
- Optional: Use compass (if magnet not labelled)

### Construction:

1. Stick two pins, tip to tip, on tape so that pin heads protrude off the edges of the tape.
2. Stroke pins gently with the bar magnet.
3. Lay the thread over the tape at 90° to the pins so the end overlaps the pins. Close up the tape to hold the thread and pins in place.
4. Feed thread through the straw so the pins on the tape hang freely below.
5. Tape thread to the top of the straw, so the straw is a handle for the magnetic field detector.
6. If the magnet is not labelled, identify its north and south poles by using a compass.
7. Bring your magnetic field detector close to the north pole of the magnet. One of the pins should rotate to point to the magnet. Label this edge of tape north.
8. Bring it close to the south pole of the magnet; the other pin should point to the magnet. Label this pin south.

**Discussion**
This is a simple, but mechanically similar version of the magnetometers used to explore other planets. On a spaceship, a magnetometer must be mounted outside on a long boom, so that it is not influenced by any of the electric or magnetic systems on board.

**Tip:**
ManitobaRocks.info web site provides excellent learning tools that highlight geological regions across the province. Girls can also study types of rocks and geological eras on the site, including Make-A-Map. Once their research is complete, girls can report back on their findings.

# 4.What do Paleontologists do?

SBG

*A paleontologist is a scientist who studies fossilized remains of many organisms to try to better understand what the Earth was like in the past. One approach they use is uncovering the bones of creatures and trying to put them back together.*

## Activity Purpose:

To explore how paleontologists recreate the skeleton of a creature by putting the found bones back together.

## Supplies:

- Popsicle® sticks or tongue depressors
- Paint or markers
- Stencil of a dinosaur or desired creature
- Masking tape

**Leaders:**
To support learning, invite a Manitoba geologist to help instruct on this activity. Contact the Manitoba Geological Survey at: minesinfo@gov.mb.ca

## Directions:

1. On a flat surface, like a table top, line up about 10 Popsicle® sticks (or the number needed for the size of the stencil), side by side, with flat sides facing up as in the diagram. Use a strip of masking tape along the top and bottom to hold the sticks in place.
2. Flip over the taped-together sticks. Lay a stencil over the Popsicle® sticks and use the paint or the markers to draw the dinosaur. Let it dry.
3. Remove tape from the back of the Popsicle® sticks.
4. Have girls try to recreate the creature.
5. The difficulty of this activity can be changed by changing the size of the sticks used, by giving them the Popsicle® sticks of more than one creature to sort and recreate, and by hiding them or burying them in sand or around the room.

# 5.Go on a GeoTour in Manitoba

BGP

*Follow Manitoba geoscientists on road trips to various locations in Manitoba and learn about the province's geological features and history.*

## Activity purpose:

To help Guides learn about the geology of Manitoba and to job shadow a geoscientist. Visit ManitobaRocks.Info (click on GeoTours on the top menu bar).

## Directions:

Have Guides watch the videos and engage in a discussion (Have any of the girls ever visited or heard about any of these sites? What do they know? What did they learn from the videos? Which sites would they like to visit?).


BG
PR

# 6.Get to Know a Geoscientist

*Geoscience is a very broad field of study with a wide range of specializations that include sedimentology, volcanology, paleontology and more. Explore what type of geoscientific work you might enjoy.*

## Activity Purpose:

To explore different geoscience careers.

## Supplies:

- Earth Sciences Canada Careers web site (earthsciencescanada.com/careers), or movies, museum installations, books, articles
- Find a geoscientist you can interview (contact minesinfo@gov.mb.ca)
- Use a Smartphone or camera to record the interview (optional)

## Directions:

1. Girls can work in pairs to explore the Earth Science Canada Careers website and career map to become familiar with some of the different types of geoscience-related jobs. Girls may select one or two careers they find interesting and report back to your Guides group on why they chose the career path they did.
2. Have girls develop a questionnaire and prepare to interview a geoscientist.
3. Prepare a short list of questions, such as: What is most interesting about your job? What is the most exciting location you've worked at? What are some of the things you have discovered?
4. Have girls post their interview online.


## Principle 7:

# Geoscience rocks!

## *Expand your geoscience horizons!*

1. Visit and explore exciting Manitoba rock and ‘geo’ and mineral-related sites
2. Attend a meeting or field trip with a local rock or minerals club
3. Plan a Manitoba Provincial Legislative building field trip
4. Plan your own fun geoscience-related activity!

# Optional Activity #1

SBG PR

*Visit and explore exciting rock and mineral-related sites around Manitoba. Connect on Facebook where applicable.*

**Agate Pits – Souris Rock Shop**
Junction of Hwy #2 & #250, Souris
204-483-2561
SourisRockShop.com

**Canadian Fossil Discovery Centre**
111-B Gilmour Street, Morden
204-822-3406
DiscoverFossils.com

**GeoTours**
Learn about fascinating rock and mineral formations around Manitoba.
ManitobaRocks.info (see 'GeoTours')

**Heritage Museum North**
162 Princeton Drive, Thompson
204-677-2216
HeritageNorthMuseum.ca

**Manitoba Museum – Geology & Paleontology**
190 Rupert Avenue, Winnipeg
204-956-2830
ManitobaMuseum.ca

**Oak Hammock Marsh Interpretive Centre**
204-467-3300, Toll-Free
1-888-50-MARSH (62774)
OakHammockMarsh.ca

**Northern Manitoba Mining Academy**
2 Hart Avenue, Flin Flon, MB R8A 0G4
204-687-7038

**Snow Lake Mining Museum**
Contact: Paul Hawman,
email: slmuseum@mymts.net
163 Poplar Avenue, Snow Lake
204-358-7867
SnowLake.com
(Also see: MB Star Attraction at travelmanitoba.com/listings/snow-lake-mining-museum/6960)

**Stonewall Quarry Park**
Heritage Arts Centre
166 Main Street, Stonewall
204-467-7980
StonewallQuarryPark.ca

**The Ed Leith Cretaceous Menagerie**
University of Manitoba, Wallace Building
125 Dysart Road, Winnipeg
204-474-9371
umanitoba.ca/geoscience/cretaceousmenagerie/welcome.htm

**The Mineral Society of Manitoba**
(Ask about membership and become an official 'Rockhound'!)
mineralsocietyofmanitoba.weebly.com

# Optional Activity #2

SBG PR

*Attend a meeting or field trip with a local rock and mineral club like the Mineral Society of Manitoba*

**Geo Fact**
Amber, a fossilized tree resin, may contain remains of insects. It was first reported in Canada by geologist Joseph Burr Tyrrell in 1891 in beaches along the west shore of Cedar Lake in western Manitoba.

# Optional Activity #3

SBG PR

*Visit the Manitoba Legislature to learn about the history, architecture and geology of the building that houses the Manitoba government.*

## Activity Purpose:

To help girls explore and learn about the rock used to build the Legislature, including local Tyndall Stone®, limestone, granite and breccia from locations in Canada, the USA, Quebec, Italy and France.

## Supplies:

Guidebook (manitoba.ca/iem/info/libmin/gacmac/OF2013-5_FT-B1.pdf)

## Directions:

1. Arrange a tour of the Legislature, preferably with a professional on-site guide. Explain the purpose of your visit and in learning the details of the geology of the Legislature.
   gov.mb.ca/legislature/visiting/tour.html
2. Have the girls give a short presentation on aspects of the tour that were of greatest interest to them.

# Glossary of Terms

## A.

**Anticline:** An arch-shaped fold.

**Aquifer:** A saturated area that stores water. The water in aquifers is extracted from the ground to supply drinking water.

**Asteroid:** A small rocky body, orbiting the sun. Most asteroids orbit the sun in the asteroid belt, located between Mars and Jupiter.

**Asthenosphere:** The asthenosphere is solid upper mantle material that is so hot that it can be very fluid as it rides on the asthenosphere.

## C.

**Cast:** If an empty mold is filled with sediment, an (external) cast can be made. Molds and casts are three dimensional and preserve the surface contours of the organism.

**Convergent Plate Boundary:** A destructive plate boundary where plates are moving together – subduction zone.

**Core:** The metallic centre of the Earth. The outer core is liquid. The inner core is solid.

**Crushed Stone, Sand and Gravel (Aggregates):** Bedrock or sediment (sand and gravel) that is extracted and used in construction.

**Crust:** The Earth is made up of layers, with the crust as the outermost layer.

## D.

**Delta:** Fan shaped deposit of sediment that accumulates at the mouth of a river.

**Depositional Landform:** A landform caused by deposits over time of weathered and eroded surface materials.

**Divergent Plate Boundary:** Where the Earth's plates are moving apart (sea floor spreading) to create new crust.

## E.

**Erosion:** The removal of soil, sediment or rock fragments from a landscape. Erosion stops when the transported particles settle (deposition).

**Erosional Landform:** A landform caused by removal of weathered and eroded surface materials by wind, water, glaciers and gravity.

**Extrusive:** (Volcanic) rocks hardened from lava at the Earth's surface.

## F.

**Fault:** A fracture that forms in rocks. A normal fault is a fault where one slab of the rock is displaced up and the other slab down. It is created by tensional forces acting in opposite directions. A reverse fault is a fault where one block of rock is forced up and over another. A strike-slip fault is a fault in which blocks of rock slip sideways, past each other. Folding and faulting provide evidence plate tectonics.

**Fold:** A bend in rock that is the response to pressure. Folds are most visible in rocks that contain layering.

## G.

**Geologic Time:** The geologic time scale (GTS) is a system of chronological measurement that relates stratigraphy (geology that studies rock layers and layering) to time, in order to describe relationships between events that have occurred throughout Earth's history.

**Glacier:** A slowly moving mass or river of ice formed by the accumulation and compacting of snow on mountains or near the poles.

**Groundwater:** Water stored under the surface of the Earth in spaces found in rocks, sediment and soil.

## I.

**Igneous Rock:** Derived from the Latin word for fire. Rock formed when molten rock (magma or lava) hardens. May form with or without crystallization.

**Intrusive:** (Plutonic) rocks that solidify from magma under the surface of the Earth.

## L.

**Lava:** Molten magma that reaches the Earth's surface, often at a volcano.

**Lithosphere:** Composed of both the crust and the portion of the upper mantle of the Earth. Behaves as a brittle, rigid solid. The lithosphere is about 100 kilometres thick.

## M.

**Magma:** Molten rock that occurs below the surface of the Earth.

**Mantle:** A highly sticky (viscous) layer between the crust and the outer core.

**Metamorphic Rock:** Derived from the Greek words meta (meaning changed) and morph (meaning formed). Formed from the transformation of existing rock, which are changed physically or chemically as a result of exposure to heat, pressure, or fluids.

**Meteorite:** Space material that falls to the surface of the Earth (named according to types of materials they come from).

**Mineral:** A naturally-occurring inorganic solid with a specific chemical composition and crystalline structure.

**Mining:** The process of removing minerals, metals or other geological materials from the Earth.

**Mold:** The outcome when an organism that has been buried in sediment decays or dissolves, leaving an empty cavity, or a hole.

## N.

**Normal Fault:** A simple fault in which blocks of rock move up or down.

## P.

**Paleogeography:** The position of continents and oceans in the geological past.

**Pit:** Location for extraction of unconsolidated earth materials (sand and gravel) using excavators (front-end loader).

**Plate Tectonics:** A theory describing the large-scale motions of Earth's lithosphere (rigid plates of the Earth's crust) and built upon the theory of continental drift. The Earth has seven or eight major plates and several minor plates.

**P wave:** A seismic wave that shakes the ground back and forth in the same direction and the opposite direction, as the direction the wave is moving. P waves move through solids and liquids.

## Q.

**Quarry:** Location for extraction of consolidated earth materials (bedrock). Blasting is required to liberate the rock for processing.

## R.

**Reclamation:** The process that takes place to restore land after mine site facilities and infrastructure have been removed. All soil cover materials, vegetation and surface water features modified during the life of the mine must be restored to a quality, quantity and appearance that is as close as possible to it natural state before mining began.

**Rehabilitation:** Treatment of land from which crushed stone, sand and gravel have been excavated, restoring the land to its former use or condition, or changing it to another use or condition of surrounding land.

**Remediation:** Removal of pollution or contaminants from soil, groundwater, sediment, or surface water for the protection of human health and the environment.

**Rock:** Any natural combination of minerals; an aggregate of minerals.

**Rock Cycle:** A model that illustrates the formation, breakdown and reformation of a rock, resulting from sedimentary, igneous, and metamorphic processes.

## S.

**S Wave:** A seismic body wave that shakes the ground back and forth at a 90 degree angle to wave direction and movement. S waves move only through solids.

**Sedimentary Rock:** Derived from the Latin word sedimentum, meaning to settle. Formed by material deposited at the Earth's surface and within bodies of water.

**Soil:** Naturally-occurring mineral or organic material at least 10 cm thick that occurs at the earth's surface and can support plant growth.

**Syncline:** A bowl-shaped down-fold.
Transform Plate Boundary: Horizontal motion in plate tectonics.

## U.

**Uniformitarianism:** A law stating that the present is the key to the past.

## W.

**Water table:** The level in the ground, below which, all spaces in rock, sediment and soils are filled with groundwater.

## X.

**Xenolith:** A fragment of old rock caught or stuck in a new igneous rock (see Intrusive).