The Canadian Rock Exploration Playscape

Alex Munro School, Calgary

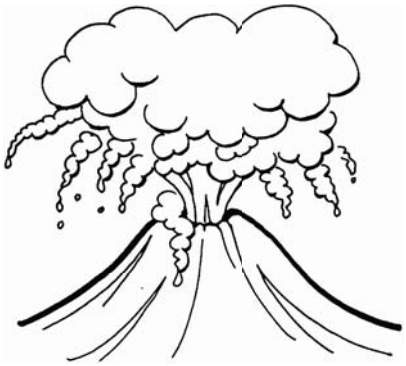
Rocks and Minerals

Minerals are naturally occurring substances that have specific physical and chemical properties. Physical properties include crystal structure, how it reflects light (lustre), hardiness and colour.

Sometimes a mineral is made from only one element, like a diamond, which is just carbon. More often it is made from a mixture of elements. For example, quartz is silicon dioxide, which is one part silicon and two parts oxygen (SiO_2)

Rocks are made from one or more minerals.

Three Classification of Rocks



1. Igneous

When molten rock material cools and solidifies, igneous rocks are formed.

Extrusive Igneous Rocks

Also called volcanic igneous rocks.
When molten rock erupts on the surface, it cools quickly and forms small crystals. Examples of extrusive igneous rocks include obsidian, basalt, pumice, rhyolite, andesite, scoria and tuff.

Obsidian looks like glass because it cooled so rapidly that the atoms are unable to form a crystalline structure. Usually it is black, but can also be brown or green, and rarely blue, orange or yellow. It was used to make sharp tools like arrowheads, knives and scrapers. Today, obsidian is used to make extremely sharp scalpels.

How Stone Age blades are still cutting it in modern surgery. (April 2, 2015), CNN. Retrieved from www.cnn.com/2015/04/02/health/surgery-scalpels-obsidian/

Granite is one of the best known igneous rocks. It is used to make counter tops, floor tiles, paving stones, curbing and monuments. Look at the polished surface of the granite in the Canadian Rock Exploration Playscape. Can you see crystals?

Intrusive Igneous Rocks

Intrusive igneous rocks form below the Earth's surface. They cool slowly and this allows large crystals to form. Examples include granite, granodiorite, diorite, gabbro, pegmatite and peridotite.

2. Sedimentary

Sediment is made from minerals, weathered rock, small pieces of plant, or other organic materials that are broken down into small pieces through the actions of water, air or living things. Over a long period of time, as sediment builds up on the Earth's surface, it is then compressed and cemented into sedimentary rock.

Clastic sedimentary rocks include shale, siltstone, sandstone, conglomerate and breccia. They are formed as rocks and minerals break down (mechanical weathering) and the debris is compressed into new rock.

The City of Calgary was nicknamed 'Sandstone City.' After a big fire in 1886, town officials recommended that instead of wood, sandstone should be used to build civic buildings and churches. The sandstone era ended with the onset of World War I, but many of these buildings are still used today.

www.cbc.ca/news/canada/calgary/calgary-s-great-fire-of-1886-sparks-sandstone-city-1.1111308

Lougheed House is a beautiful sandstone mansion located in downtown Calgary. For information, visit *www.lougheedhouse.com*.

Chemical sedimentary rocks include iron ore, chert, flint, rock salt and some dolomites and limestone. They form when minerals that have been dissolved in water precipitate from a solution. That means the minerals are separated from the water and become solid again.

Gardeners will use ground-up limestone or dolomite, known as lime, to make soil less acidic.

In Calgary, soil often contains naturally occurring limestone or dolomite, and this makes it alkaline instead of acidic. This is why Calgary gardeners rarely use lime.

Organic sedimentary rocks form when plant or animal debris accumulates. Examples include coal, and some dolomites and limestones.

Coal is formed from accumulation and compression of plant debris, usually in low oxygen environments such as swamps. It takes a very long time for debris to accumulate, which is why it will take thousands of years to create a thick seam of coal.

Have you camped at Lake Wabamun in Alberta? There are large coal beds around the lake and you will often see coal on the beaches.

Why can dolomites and limestones be either chemical or organic sedimentary rocks?

3. Metamorphic

Rocks that are buried deep under the Earth's surface are exposed to extreme heat, pressure and tectonic movements within the earth. Exposure to these extreme conditions alters texture and mineral composition, and creates metamorphic rocks. Erosion and shifting of the Earth's crust can bring them to the surface.

Foliated metamorphic rocks appear layered or banded. Examples include gneiss, slate and schist and phyllite.

Non-foliated metamorphic rocks do not have layers or bands. Examples include quartzite, marble, hornfels, and novaculite.

Here are some examples of how rocks change from one type to another.

Slate is created when sedimentary shale is metamorphosed.

When slate continues to be exposed to extreme heat and pressure, it changes into schist.

Gneiss can be formed by the metamorphism of schist or igneous granite or granodiorite.

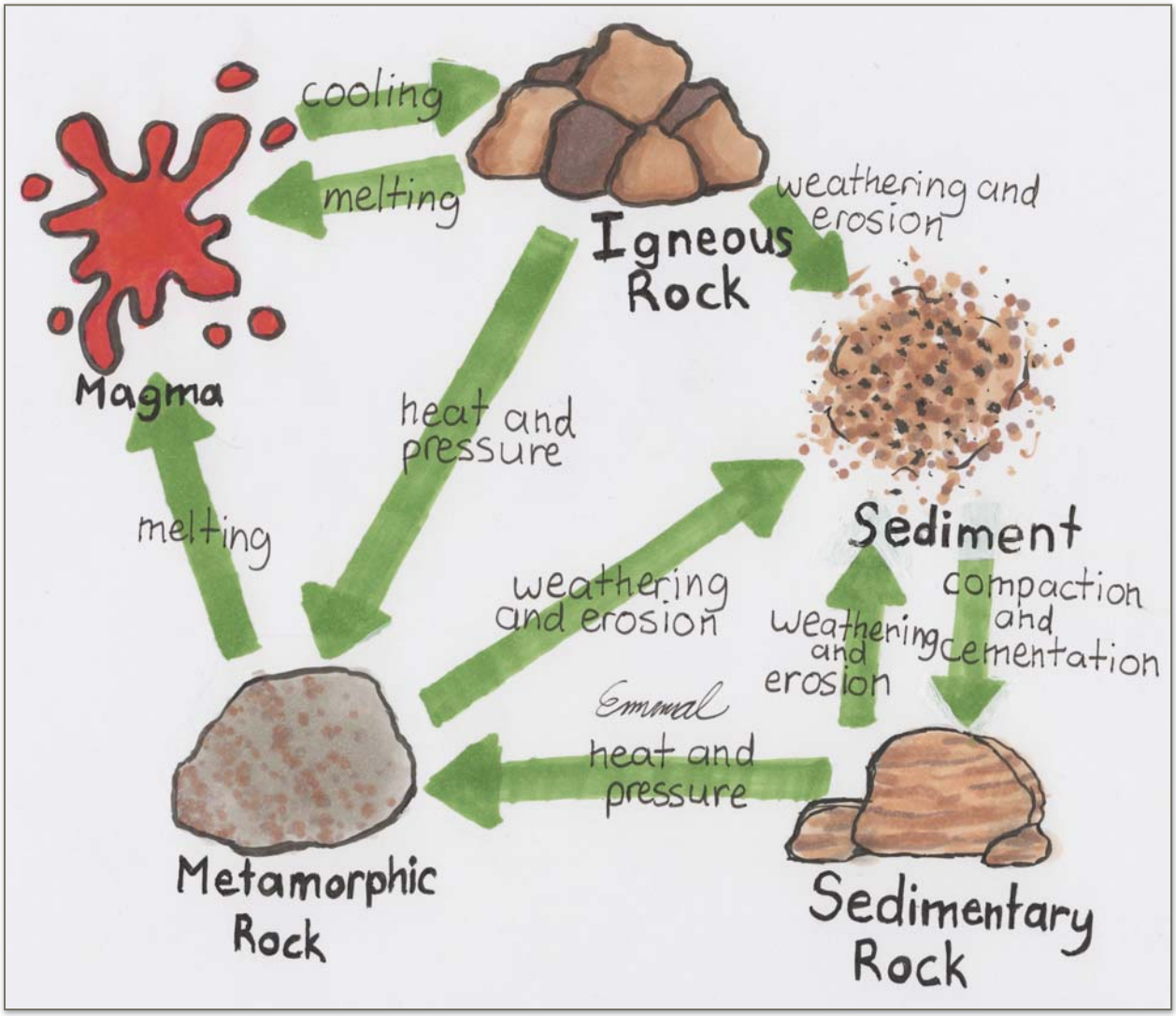
Quartzite is a metamorphic rock formed from the sedimentary sandstone.

Marble is formed by the metamorphism of sedimentary limestone.

Look at the polished surface of the gneiss in the Playscape.

Can you see the banding pattern?

The Rock Cycle



Artwork by Emma Cahoon, Alex Munro School Alumni

Each type of rock is formed in different ways, and each type can be changed into other types of rocks. This process takes a very, very long time. Millions of years!

Most rocks on earth began as igneous rocks.

Can you explain why most rocks on earth began as igneous rocks?

Rocks in the Canadian Rock Exploration Playscape

Sedimentary

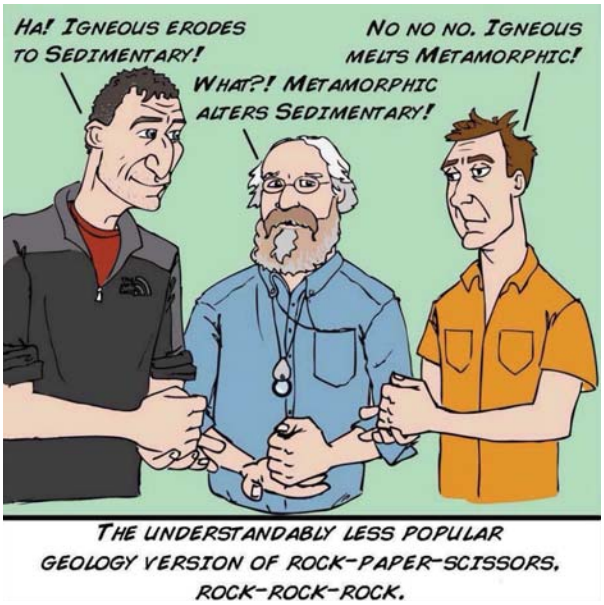
Shale

from a quarry in Radium Hot Springs

Shale is formed when silt and clay is compressed into solid layers of rock. It is layered and it splits easily into thin pieces. The shale in the Canadian Rock Exploration Playscape is harder than usual because it is on its way to metamorphosing into slate.

Look at the Rock Cycle Diagram. Where do you think this rock is in the cycle?

The Burgess Shale in Yoho National Park is a UNESCO World Heritage Site.



- The Burgess Shale in Canada's Yoho National Park is one of the world's most famous fossil sites. Preserved within the rock layers are remains of soft-bodied animals, plants and algae that died and settled into the mud before the sediment was compressed into shale. The fossils are from the Cambrian period.
  www.burgess-shale.bc.ca
- Natural gas and oil can be produced from some types of shale.
  www.csur.com/sites/default/files/shale_gas_English_Web.pdf
- Shale is used in combination with limestone to produce cement.
- Shale is a common rock on the planet Mars.
  http://geology.com/stories/13/rocks-on-mars/

Sedimentary
Limestone
from quarries in Exshaw and Deadman Flats by Canmore, Alberta

Fossil in Tyndall limestone used as building stone. Photo credit: www.geocaching.com

Limestones are made of calcium carbonate. The source of calcium carbonate determines if limestone is a chemical or organic sedimentary rock.

Organic Limestone: Limestone forms in shallow, warm marine waters. Many sea creatures are capable of forming calcium carbonate shells or exoskeletons by using minerals found in sea water. As these creatures die, shells, corals and skeletons are broken down and accumulate on the sea floor to create lime mud.

Chemical limestone: Sometimes as sea water temperature increases in shallow waters, calcium carbonate dissolved in the water is deposited in solid form on the sea floor as lime mud.

Overtime, as lime mud gets covered by sediment and is buried deeply, the weight generated by overlying sediments slowly cements lime mud into limestone. If fossils are present, it is called fossiliferous limestone and indicates that the limestone is organic.

If limestone is formed in oceans, why do we have so much of it in Alberta and British Columbia?

Our limestone was formed approximately 360 million years ago during the Devonian period. Back then, Alberta had perfect conditions to create lime mud because it was covered by a warm ocean and was home to many sea creatures!

- Limestone is used as an additive in making steel, and in making a variety of industrial chemical products.
- Limestone is used in blocks to construct buildings, in making cement and is often crushed for making roads. The small rocks on the ground in our playscape are crushed limestone.
- Limestone is quarried at the Lafarge Cement Plant in Exshaw for use in making cement. Graymont also mines limestone at Exshaw to make lime and a variety of other products.
- As the mountains were formed, some of the limestone was subjected to intense heat and pressure, and metamorphosed into marble.
- Tyndall limestone from Manitoba is famous for its colour, beauty, strength and fossils. **www.gac.ca/TyndallStone.pdf**

Sedimentary
Dolomite

from a quarry in Kelowna

Dolomite is the name of a mineral, and also refers to a type of rock, sometimes called dolostone.

Dolomite rocks, or dolostone, originate in the same sedimentary environments as limestone: warm, shallow, marine environments where calcium carbonate mud (lime mud), accumulates in the form of shells, coral fragments, and precipitated calcium carbonate. Dolomite is thought to form when lime mud or limestone is altered by magnesium-rich groundwater. This is known as dolomitization.

Limestone is composed primarily of calcite, a rock-forming mineral with a chemical formula of $CaCO_3$ (Calcium carbonate).

Dolomite and limestone are very similar. In fact, it is believed that limestone is altered into dolomite by magnesium-rich groundwater. The chemical formula for dolomite is $CaMg(CO_3)_2$.

Sometimes, a limestone is only partially altered and is called a dolomitic limestone.

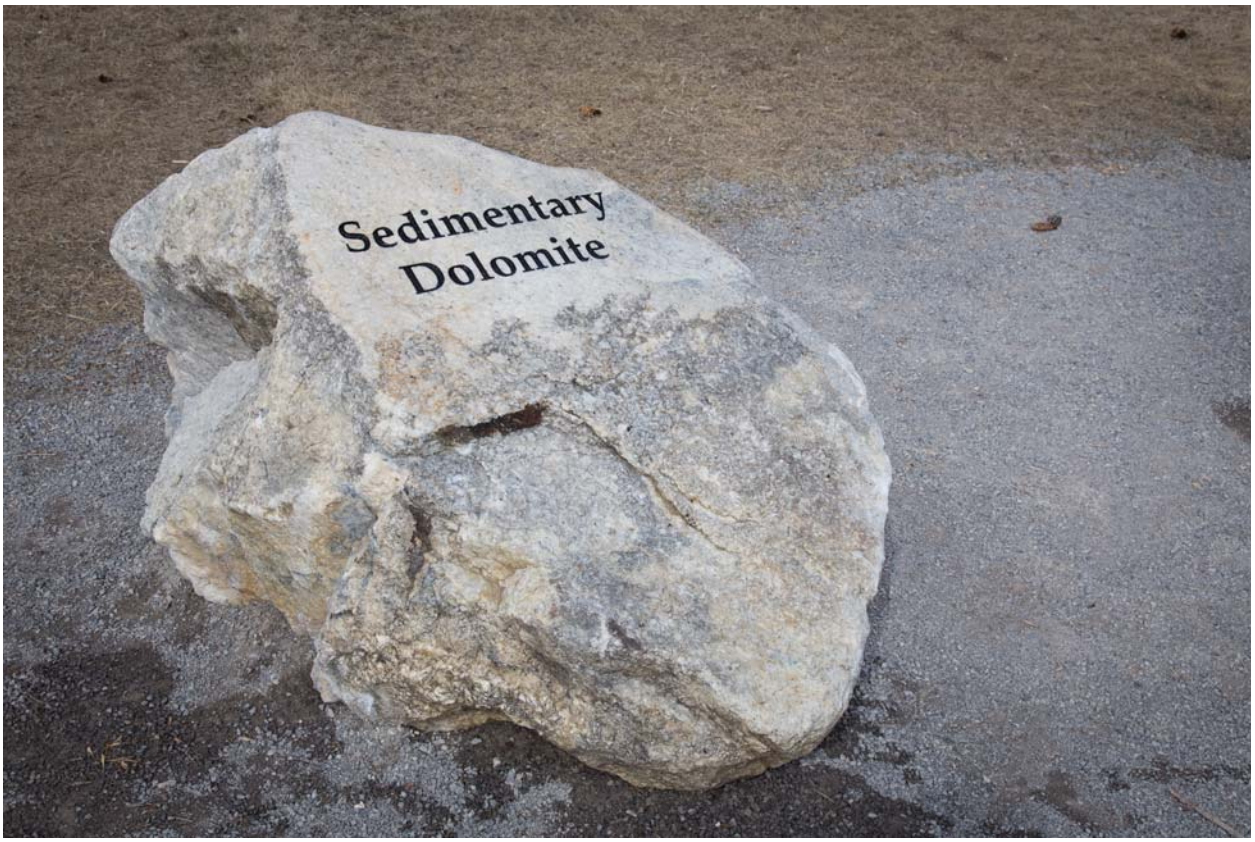
West of Calgary, a large part of the front ranges of the Rocky Mountains are made up of dolomite and limestone. These rocks typically are light grey, to dark grey in colour.

Like limestone, when dolomite is exposed to extreme heat and pressure, it recrystallizes. Metamorphism of dolomite rock creates large crystals, and transforms it into dolomitic marble.

Look at the dolomite in the playscape. How big are the crystals? Has this sedimentary rock started to metamorphize?

Example of fine grained dolomite rock.

Granular dolomite. The coarse crystalline texture is a sign of recrystallization, often caused by metamorphism.



- Dolomite can be cut into blocks and used to make buildings.
- It is crushed for use as gravel to build roads, make concrete and is used as an additive in making steel.
- The magnesium in dolomite can be chemically separated to make pure magnesium metal.
- When limestone is converted to dolomite, spaces often form within the rocks. These empty spaces can trap fluids like oil and natural gas. This is why geologists often search for oil and natural gas in Alberta's dolomite basins.
- Lead and zinc deposits are also often found in dolomite.

Dolomite is very common on earth, but is rarely found in modern sedimentary environments. This puzzles scientists. One possible explanation is that sulphur bacteria helped form dolomite crystals. This type of bacteria uses sulphur instead of oxygen for energy production, and they live in oxygen free environments. It appears that large amounts of dolomite were deposited into seabeds during periods of time when the sea water was free of oxygen.

www.sciencedaily.com/releases/2012/06/120607105815.htm

Sedimentary

Sandstone

from west Calgary

Sandstone is made from sand-size grains of minerals and rock that, over a long period of time, have been cemented together by intense pressure to form rock.

‘Sand’ in sandstone refers to the size of particles used to make the rock rather than the type of mineral or rock grains.

The sandstone boulders in the playscape and garden were found in Calgary, and are from the Paskapoo Formation. Sandstone in the Alberta Paskapoo Formation was deposited during the Palaeocene era, approximately 60 million years ago.

The sediments that make up the Paskapoo formation were eroded from the rising Rocky Mountains. Rivers and streams carried the sediments eastwards, and deposited them in broad floodplains that covered much of southwestern Alberta.

These sediments mixed with plant debris from swamps in the flood plain, and were then buried and compacted to form sandstone, shale and coal deposits.

Paskapoo sandstone can be seen in many parts of Calgary, including Confluence Park near Beddington Trail.

Photo courtesy of the Legislative Assembly of Alberta

The upper floors of the Alberta Legislature Building (above) in Edmonton feature sandstone from the Glenbow Quarry in Calgary. The first floor is faced with granite from Vancouver Island, and some interior fittings used imported marble.

The Calgary Public Building (right) was built in 1930-31, and now houses the performing arts centre. The exterior features Tyndall limestone cladding from Manitoba and inside is marble flooring from Quebec.

The City of Calgary, 2007

Igneous

Granite

from a quarry in Drayton Valley.

Granite is a coarse grained rock that is formed as molten rock material slowly cools under the earth's surface. The slow cooling process creates large crystals mostly composed of quartz (clear pink, white or black), feldspar (pink, red), and mica (dark brown or black).

Granite outcroppings that we see in the Canadian Shield, and in the Columbia Mountains in southeastern British Columbia, have been pushed to the surface, and the overlying sedimentary rocks have been worn away. Many granite boulders, like the one in the playscape, are ice rafted glacial erratics. This means they sat on top of a glacier, and as the glacier grew and moved over thousands of years, it transported the rock to a new location.

Over millions of years, much of the Earth's granite has been broken down into sediment. This sediment was then buried and compressed into sedimentary rocks.

- Granite is a hard rock that does not scratch easily, resists weathering, can bear significant weight and can be polished so it has a beautiful shine. **Keeping this in mind, can you think of ways people can use granite?**

The granite in the playscape stands between two sedimentary rocks. What is the relationship between igneous and sedimentary in the rock cycle?

Look at the different coloured crystals. What minerals do you think might be in this granite?

Metamorphic
Gneiss (pronounced 'nice')

from a quarry in Revelstoke

Gneiss is a foliated metamorphic rock. In geology, foliation refers to layers of rock. When you look at a gneiss, you can see bands, or layers in the rock.

Intense heat and pressure causes minerals in rocks to recrystallize. Some crystallized minerals are bigger than others, and the different sizes of crystals sort themselves into layers. This layered metamorphic structure makes minerals in the rock more stable.

Can you see the banding pattern in the gneiss in the playscape?

The layered, or banded appearance, is what defines a gneiss rather than its mineral composition.

Gneiss can be formed from schist, granite or granodiorite. Metamorphism usually does not alter the mineral composition of the granite or granodiorite, but it does change the structure of the rock. As the minerals recrystallize, they tend to separate into layers.

The gneiss in the playscape is likely a granodiorite gneiss. It is similar in composition to granite gneiss but contains more plagioclase, a type of feldspar mineral.

About 76 million years ago, when the Rocky Mountains were forming near modern day Revelstoke, molten granodiorite magma was pushed up into older, sedimentary rock. As the mountains pushed and forced their way up, the cooling magma was squeezed so hard that the minerals recrystallized into layers, and our gneiss was formed.

- Gneiss is often used as crushed stone in road construction, paving, building facades and ornamental stone in gardens.

Feldspar **is the name of a large group of rock-forming minerals that make up over 50% of Earth's crust. They are found in igneous, metamorphic, and sedimentary rocks in all parts of the world.**
http://geology.com/minerals/feldspar.shtml

Quartz **is a mineral made of silicon dioxide (SiO_2). It is the most abundant mineral found at Earth's surface, and its unique properties make it one of the most useful natural substances.**
http://geology.com/minerals/quartz.shtml

Metamorphic
Schist

from a quarry in Kelowna

Prior to the 18th century, schist, shale and slate were used interchangeably to describe the same rock. Now we recognize that they are at different places in the rock cycle. Shale is transformed through metamorphism into slate, then phyllite and finally schist. If schist is metamorphosed further, it will turn into gneiss.

Look at the schist in the playscape. Can you see how the layers have been folded and twisted as the rock was squeezed during metamorphism?

Common minerals found in schist are micas, feldspars and quartz. Can you see any quartz in the schist in the playscape?

Metamorphic
Quartzite

from a quarry in Cremona

When sandstone that is composed primarily of quartz mineral sediments, is altered by metamorphism, it turns into quartzite.

When the Rocky Mountains were formed between 50 and 100 million years ago, quartzite rock beds were pushed to the surface. During the glacial age 10,000 years ago, the quartzite boulder in the playscape caught a ride on a glacier, and travelled from Jasper to southern Alberta. It was a very slow ride and took thousands of years.

The quartzite in the playscape is known as a glacial erratic, and is the same kind of rock as 'The Big Rock' in Okotoks. Big Rock also rode a glacier but it is much bigger. It weighs about 16,5000 tonnes! **www.history.alberta.ca/okotoks/**

There are several variations of the legend told by the Blackfoot people about how Big Rock arrived on the prairie, and why it is split. The site is of great spiritual significance, and the name of the erratic and nearby town was derived from the Blackfoot word for rock, Okatok.

Okatok, a video by Shawna Koski. **https://vimeo.com/117641605**

Okotoks glacial erratic. Photo by R. McQueen

You don't have to go all the way to Okotoks to see a glacial erratic. In nearby Confluence Park, a glacial erratic known as Split Rock is located on the north bank of Nose Creek.

Zach's Viewpoint

Hi. My name is Zach. I am a student at Alex Munro School, and I am legally blind. I also like rocks.

Rocks just don't look different, they feel different. One of my favourite rocks in the playscape is the schist. The layers make it feel like wood, and it is different from all the other rocks. The quartz that sticks out of the schist feels rougher, just like everyday rocks and pebbles.

The granite and quartzite are my other two favourite rocks. I like how the roughness of a rock tells a story about its life. For example, the quartzite rode a glacier! All the rough edges show it was not always a smooth ride. Many of the rocks that travelled to southern Alberta on glaciers have minerals in them that are not found here. Geologists can look at the minerals in the rocks, and then they know where the boulder started before it travelled on a glacier. We think the quartzite in the playscape came from Jasper, just like Big Rock near Okotoks.

The names of the rocks are engraved into the boulders and I can feel the letters. I have a good memory so I can remember all the letters and read the words. On some of the rocks, the side with the letters is polished. It feels so smooth, like glass.

When you visit the playscape, I hope you feel the rocks. What is your favourite?

Zach, Grade 5. 2017

Resources

geology.com
Geology and Earth Science News
This site is financed through advertising revenue. As of 2017, this site is operated by a staff of four people who work in the USA:
Hobart King (Ph.D., M.S. Geology, West Virginia University; B.S. Geology, California University of Pennsylvania) writes most articles. Bradley Cole (B.S. Mapping Technology, Mansfield University, 2006) serves as webmaster, photographer and graphic artist. Angela King (B.F.A. Indiana University, A.J.P. Gemological Institute of America) serves as editor and graphic artist. Laura Rittenhouse is an ecommerce professional and serves customers who purchase through the online store.

wwwf.imperial.ac.uk/earthscienceandengineering/rocklibrary/index.php
Imperial College Rock Library, London
Information about rock samples from the collections of the Department of Earth Science and Engineering and the Royal Schools of Mines.

www.sciencekids.co.nz
Science Kids is the home of science & technology on the Internet for children around the world. Learn more about the amazing world of science by enjoying our fun science experiments, cool facts, online games, free activities, ideas, lesson plans, photos, quizzes, videos & science fair projects.

http://ees.acadiau.ca/geocareer.html
Careers in Geology
Acadia University, Earth and Environmental Science

www.youtube.com/watch?v=Wpr9WmFpYFw&feature=youtu.be

This youtube video showcases the Alex Munro School 'Rocks and Minerals' song. The song was written by one of our grade three teachers, Mr. D. Geoffrey Bell, and performed and illustrated by Alex Munro grade three students. See the lyrics on page 19.

http://gg.eas.ualberta.ca
The Canadian Rock Exploration Playscape at Alex Munro School was inspired by the Geoscience Garden at the University of Alberta.

https://www.youtube.com/watch?v=tNs1gqkYerg
Be a Rock Detective! SciShow Kids.

Books

If you Find a Rock by Peggy Christian
Ages 6 to 9

The Coolest Rock by Sherilin Chanek, 2009
Ages 5 to 9

A Field Guide to the Identification of Pebbles
Eileen Van der Flier-Keller, 2006.
The development of this pamphlet was funded by a grant from the Canadian Geological Foundation. Order from **www.harbourpublishing.com**

A Field Guide to the Identification of Pebbles in the Edmonton Area
Available from the Edmonton Geological Society. **www.egs.ab.ca**

Activities

Rock Cycle Challenge

Make copies of the playscape diagram on page 19. Draw arrows between rocks in the playscape, and explain the relationships among the different types of rock.

World Rock Library

Students, their families and community members have collected rocks from around the world for the World Rock Library. Alex Munro School welcomes your rock donation! Place your rock in a bag and label with the location and date collected, and your name. Drop it off at the school front office. Thank you!

Explore the World with Rocks

Embark on a geological journey. Borrow the suitcase that houses the World Rock Library. Unfurl the map and place the rocks on their home countries.

Ask questions!

Do you know people who live in that country? Or used to live in that country?

Can you identify which rocks are sedimentary, or igneous or metamorphic?

Are sedimentary rocks found all over the world? How about igneous or metamorphic?

Can you see similarities in the rocks that were found beside water?

Do the rocks feel different?

Do the rocks have any smell?

Can you sort the rocks into piles based on colour? Or shape? Or texture?

Do any of these countries have special geological sites that people like to visit? Or monuments or buildings made out of stone?

Have you visited a Canadian province or country not included in the World Rock Library? Do you remember what the rocks looked like?

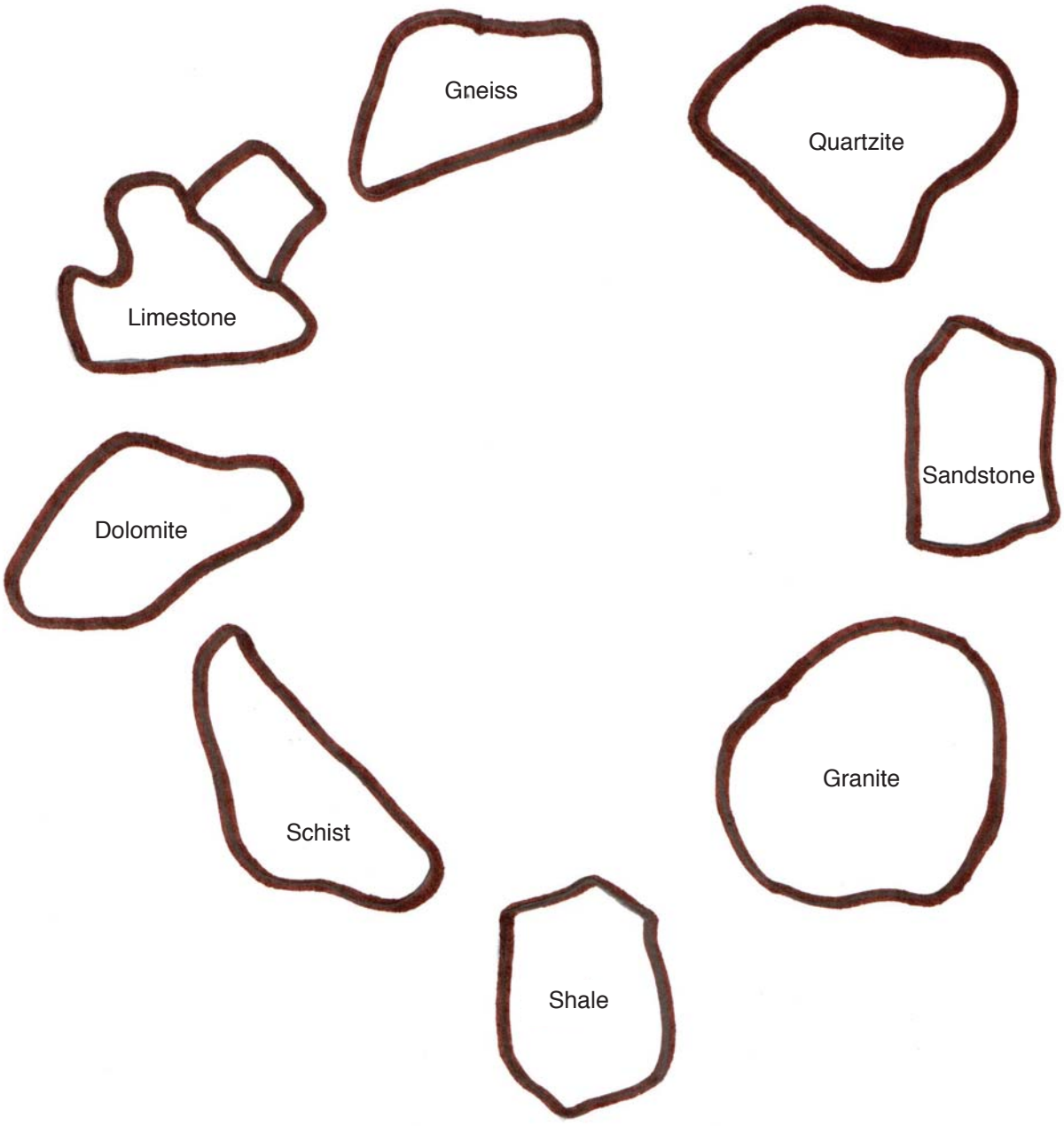
Cub Scouts: Observer Badge Requirement - Recognize and point out six different kinds of rocks or minerals.

Girl Guides of Canada: Geoscience Challenge

Rock Cycle Challenge

Sedimentary, igneous and metamorphic rocks are formed in different ways. Each type of rock can be changed into another type of rock. This is called the rock cycle.

Can you identify the relationships among the rocks in the playscape? Draw arrows and explain the connection.



ROCKS AND MINERALS

CHORUS Rocks and minerals,
Rocks and minerals,
Rocks and minerals,
We really like to rock and roll.

VERSE 1 Rocks have a **cycle** that takes millions of years.
They're changing very gradually, but have no fears,
'cause everything's connected and it's really elementary.
The **sediment** in oceans settles down to the floor,
and layers press on layers 'til there are no more.
Eventually it's layered rock we call **sedimentary**.

(repeat Chorus)

VERSE 2 Now **magma**'s really melted rock that's burning hot.
It moves around inside the Earth until it's shot
right out of a volcano as lava and smoke and ash.
Pumice is all bubbly, it floats 'cause it's light!
Obsidian is black like glass that shines so bright.
They come from molten lava so we call them **Igneous**.

(repeat Chorus)

VERSE 3 Now Igneous and Sediment'ry rocks can change.
They turn to **Metamorphic** rocks, does that seem strange?
But lots of heat and pressure can make diamonds out of coal!
And limestone turns to marble if you give it time -
a million years of heat and pressure should be fine.
and shale can turn to slate

(repeat Chorus)

VERSE 4 But ev'ry rock will break down in the wind and the rain,
Erosion slowly wears it down without any pain,
and **Weathering** will crack it up 'til all that's left is sand.

Weather together

(repeat Chorus)

Listen to the song: www.youtube.com/watch?v=Wpr9WmFpYFw&feature=youtu.be

Thank you

Alex Munro School wishes to thank the Canadian Geological Foundation for its generous grant that allowed us to purchase boulders, engrave them and transport them to the school.

Canadian Geological Foundation Fondation Géologique du Canada 1968

"The Canadian Geological Foundation was incorporated in 1968 as a charitable organization dedicated to the furtherance of geoscience in Canada. For nearly 50 years, it has played a key role in sustaining geoscience education, outreach and awareness across the country."
www.canadiangeologicalfoundation.org

Thank you to Kevin Elliot with **Set-in-Stone** for his work in sourcing the boulders, engraving, transportation and installation, and to **SurfacePro Landscapes** for building the solid base on which our playscape stands. Also, thank you to John Cranstone, geologist and long-time member of the Huntington Hills community, for his guidance and knowledgeable advice.

The Playscape Resource Guide was created by Robin McQueen, a parent volunteer at Alex Munro School.

Installation of limestone crush base. October 2016

Boulder installation. November 2016