

ROCKS 'R' RESOURCES



Education Program

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Dear Educator or Parent/Guardian

Welcome to Rocks 'R' Resources. You are entering the fascinating world of aggregates – the stone, sand, and gravel we use to build our communities. It's in virtually all of our construction materials – asphalt, concrete, glass, and brick. Knowing about our reliance on aggregates for constructing our roads, sidewalks, and buildings helps us appreciate the good fortune of living on our unique rocky planet. It also helps us ensure that we use these earth resources sustainably.

We know that during this time of COVID-19 student education may be online, at home, or in classrooms with limited attendance. We know that teachers and parents are planning for the coming year and are seeking remote learning solutions. Rock 'R' Resources was developed to help meet these challenges. Student learning can happen at home, at school, or in the community. This resource will help unlock this learning potential. Included here are video links, background information, and hands-on activities that can be completed anywhere.

Rocks 'R' Resources is based on mandated curriculum across North America – the Rocks and Minerals science unit. Here is a sample of how this resource meets curriculum standards:

Texas – Rocks and the Rock Cycle - Grade 6
Kansas – Earth's Landscape - Grade 4
Virginia - Earth Resources – Grade 6
Utah - Basic Properties of Rocks - Grade 4
North Carolina – Matter: Properties and Change - Grade 4
Colorado – Earth Systems Science – Grade 6
British Columbia – The Rock Cycle and Earth Materials – Grade 5

Everyone loves rocks. They are a way to touch and feel the history of our planet. They tangibly connect us to the primal elements of life here on Earth. Through this connection, Rocks 'R' Resources helps to foster the study of earth sciences and geology.

It has been a pleasure using our industry knowledge to create this resource for you. We hope Rocks 'R' Resources helps you and your children/students gain a new appreciation for this planet and our earth resources. And we hope you have fun doing so.

Yours,

The Rocks 'R' Resources Development Team

Introduction

The planet Earth, our home in the solar system, is a unique and precious rocky planet that provides all that we need to thrive. We use earth resources to build our cities and communities. We have to ensure that we use these resources in a sustainable way. This is the only home we have.

Rock 'R' Resources is an educational program that aims to help students gain a tangible hands-on understanding of our Earth, and the stone, sand and gravel resources it provides. We stand in the Goldilocks' zone of good fortune with this planet. Learning about what makes Earth and its resources so unique will help us take better care of what we have.

Rocks 'R' Resources is a curriculum-based classroom-ready educational resource aimed to support the Rocks and Minerals expectations in schools across North America. The resource is useful for the classroom, facilitated by teachers, but it is also an effective home learning tool with rich activities that can be completed around the home, and in the neighbourhood and community.

Acknowledgements

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www.cgced.com

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Lesson 1 - Our Rocky Planet



Where do rocks come from?

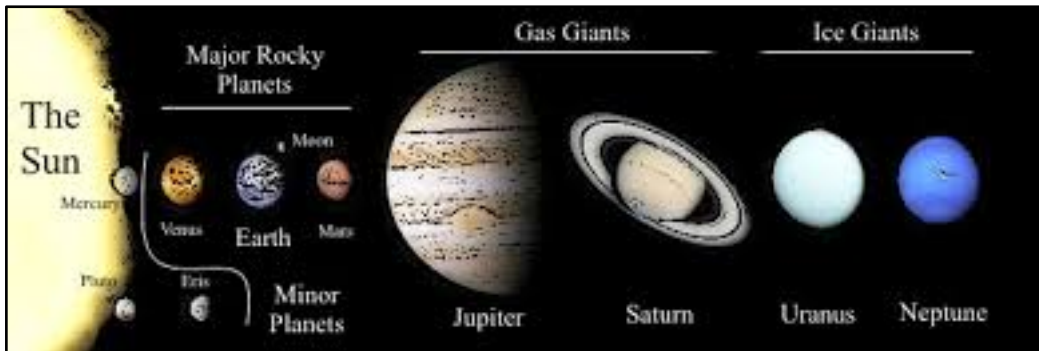
What questions do *you* have about rocks? Think of three. Write them here.

1. _____

2. _____

3. _____

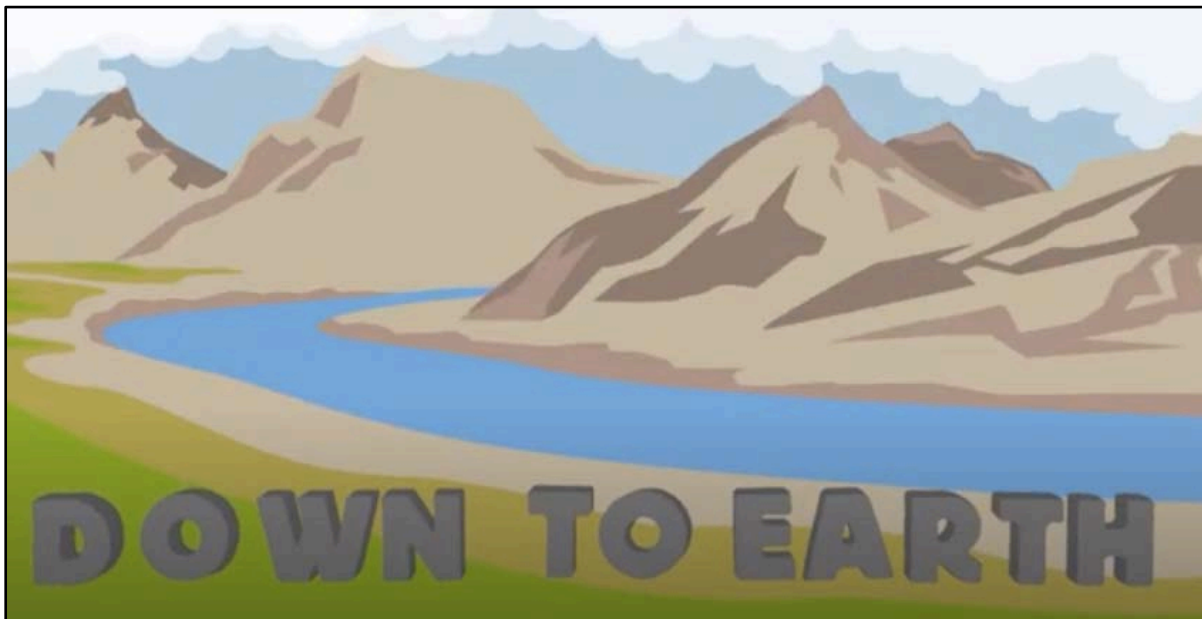
To find out where rocks come from, let's look at our planet.



Earth is called a “rocky planet.” What do you think that means? _____

Let's look at the most common theory about how planet Earth was formed.

Watch the following video to answer the questions: How Planet Earth was formed | Down to Earth
<https://www.youtube.com/watch?v=-7eTxy9yvA>



Answer these questions.

1. How did the Earth start to form? _____

2. How was the Earth's crust formed? _____

3. What's under the Earth's crust? _____

Watch the video a few times. After viewing, reflect on what you saw. Earth is called “The Third Rock from the Sun” for a reason. It perfectly describes our planet.

Earth is in the “Goldilocks” zone – not too hot, not too cool, just right. How has this made our rocky planet such a great place for life to grow? _____

Think About It

The Earth is constantly changing. The crust of the Earth is like the crust on a loaf of bread. It's quite thin – as thin as 3 miles or 5 km. beneath to the ocean floor, up to 40 miles or 70 km on the continents where there are mountains. This thin crust cracks and moves, allowing what is beneath it to erupt to the surface.

• *Run, walk or cycle 3 miles or 5 km. You have now crossed the distance between the surface of the earth and the molten mantle underneath!*

The crust is divided into huge plates that float on the mantle, the next layer, which is a thick, sticky material like peanut butter. The plates are constantly in motion; they move at about the same rate as fingernails grow. Earthquakes occur when these plates grind against each other. Mountains form when the plates collide and deep trenches form when one plate slides under another plate.

• *Make your own fold mountains, like the Rocky Mountains. You will need two shoe boxes and ten hand towels or different coloured paper towels. Lay the towels on top of one another on a table. Place the shoe boxes on either side. Push the shoe boxes together. What happens?*

The mantle is a thick layer of molten rock about 1,800 miles deep (2 890 km). Intense heat causes the rocks to rise, then cool and sink back down to the core. The mantle seems to cause the plates to move. When the mantle is squeezed through the crust, volcanoes erupt and magma flows onto the Earth's crust.

• *What things do you use on your daily life where a substance is squeezed out? (think in terms of food, or personal care products, or other things you use.)*

To learn more, go to: <https://www.scienceforkidsclub.com/earths-crust.html>

Thinking About Rocks – Definitions

• The crust of the Earth first consisted of lava flowing from volcanoes. When this magma cooled on the surface, it became a hard, solid material. The resulting rock is called *igneous*.

Define this word: _____

- After water covered much of the Earth, layers of material like sand from eroded rock and dead animals and plants sunk to the bottom of the seabed, built up and became a new kind of rock. This type of rock is called *sedimentary*.

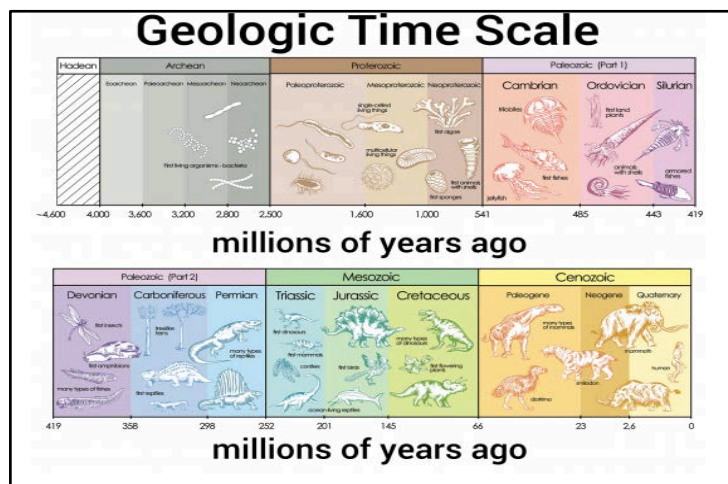
Define this word: _____

- When the crust buckles and folds, rock is pressurized and heated. This mixes into a new type of rock called *metamorphic*.

Define this word: _____

The Birth of The Earth

The Earth was born about 4.6 billion years ago. Here's how scientists have organized time throughout the Earth's history:



Source: <https://www.sciencenewsforstudents.org/article/explainer-understanding-geologic-time>

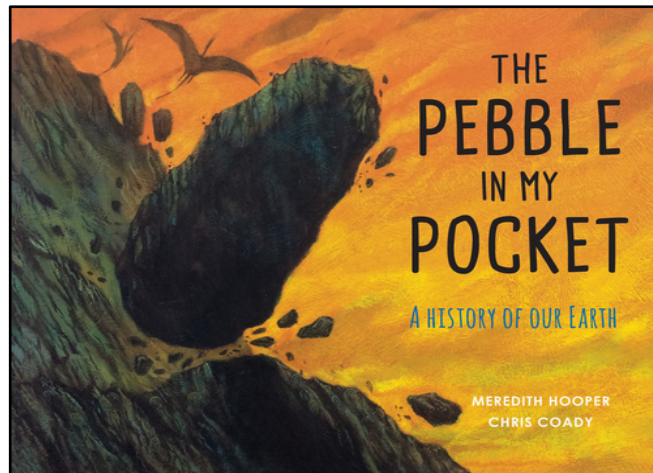
1. How long ago did dinosaurs roam the Earth? _____
2. When did the Earth see its first living organisms? _____
3. How long has mankind walked on Earth? _____

READ MORE ABOUT IT

The Pebble in My Pocket: A History of Our Earth Paperback – 5 Nov 2015

by [Meredith Hooper](#) (Author), [Chris Coady](#) (Illustrator)

Where do pebbles come from? How were they made? This book tells the story of a pebble, from its origins in a fiery volcano 480 million years ago to a busy, modern landscape. Readers follow the processes of rock formation and erosion that create new pebbles all over the world.



Lesson 2 - How Rocks Are Resources

We are fortunate to live on our rocky planet – a unique and precious environment that gives us all we need to thrive. We use the rocks on Earth to build the world we live in.

How does that happen? Let's explore how rocks are used to build the man-made environment around us – our schools, neighbourhoods, playgrounds, roads and hospitals.

Rock Facts

Aggregate is the technical name for stone, sand and gravel used in construction.

An average 2000 square foot house requires over 300 tonnes of aggregate, which equals 15 truckloads. This includes the driveways and service trenches but not the road or the sidewalk out front.

An average school needs 13,000 tonnes of aggregate, or 650 truckloads.

Investigation

Conduct an investigation into how stone, sand and gravel are the essential earth resources for common building materials such as bricks, asphalt, glass and concrete.

View the following videos. For each one, answer these questions:

- What are the natural resources used to make this product?
- What are the benefits of using this building product?
- What are the environmental costs of making this product?



How It's Made: Bricks - Discovery

<https://www.youtube.com/watch?v=SbKvhHzn4hQ>

The Big Ideas

- Bricks are one of the world's oldest building materials – fireproof, pest resistant and weather resistant – that's why we still use them.
- Bricks are often made from shale - a lightweight rock that splits easily. Topsoil is removed for two years at the quarries before the shale is extracted and processed.
- At the factory, the shale is ground to a powder, which is screened and mixed with water and extruded into one long continuous rectangular "slug". Coloured sand coats the slug and it is patterned. The slug is cut into five-foot lengths which are again cut into 20 – three-inch bricks. The three holes in the middle reduce weight and add insulation value.
- The bricks are stacked for two days of drying. Then the bricks are fired in a kiln (a big oven) for 1.5 days at 1040 degrees C., requiring a lot of heat energy.
- The bricks are quality checked before transport. They are placed in water to see if they absorb too much water or are too water resistant for the mortar.
- Each brick weighs 2.5 kg. Bricks are some of the sturdiest building materials and are energy efficient. They retain heat in winter and stay cool in the summer.

How It's Made: Paving Asphalt – Discovery

<https://www.youtube.com/watch?v=HZGfzyWKldw>

The Big Ideas

- Asphalt is best-known paving roads. The main ingredient of asphalt is stone, sand and gravel or "aggregate", which is mixed with a petroleum by-product to make it stick together.
- It begins in a pit or quarry where gravel is dug up or boulders of granite is blasted off the rock walls. The paving plant is sometimes placed on the quarry site to be more efficient. The rocks

are crushed into different sizes – less than 20 cm. at first, screened for 10 cm. and then crushed a second and third time until all the stones are smaller than 2 cm. in size.

- The rocks are separated by size into different piles. The four basic ingredients for asphalt are: sand, stone dust, 5 – 10 mm. stone and 10 – 14 mm stone. This is 95% of the mix; the remainder is liquid asphalt - an adhesive. The stone mixture is dried before mixing so that it adheres better to the asphalt.

- Asphalt is what's left after crude oil is processed for gasoline. Hot asphalt is mixed with the stone mixture. It is trucked to where it is being used. Hot asphalt cools within one hour, so it has to be used quickly. Asphalt-making plants need to be close to where asphalt is being used. Having a pit or quarry nearby, with all the stone extraction and crushing ability and the energy needed, is essential.

How Concrete Is Made - Knowledge Videos

<https://www.youtube.com/watch?v=QmQuBM0H2PQ>

The Big Ideas

- Concrete is the most used building material on earth. It built the Roman Empire. Today, it builds our gravity-defying skyscrapers and virtually everything else. It starts as a liquid then hardens into stone; it's called "liquid rock." Concrete is everywhere. How does it do it all?

- The basic formula for concrete is sand, rock, water and cement.

- Cement is the glue that coats all the material and binds it together. Cement is made from limestone, clay, iron and other materials that must be extracted from the ground. It's crushed into a powder and then heated in a long, rolling cylindrical kiln at 1500 degrees C. It becomes molten like lava. The resulting "clinker" is ground into a powder we call cement. This process requires a lot of heat energy.

- When cement is mixed with water, it undergoes a chemical transformation called hydration. Concrete doesn't "dry" in the traditional sense; the water causes the concrete to harden. The water causes it to release energy (an exothermic reaction) in the hardening process.

- New innovations in concrete are allowing it to transmit light, so that concrete buildings are not dark. Glass fibres are added to concrete to allow light to pass through it. This could transform the way we live.

How Glass is Made

<https://www.youtube.com/watch?v=ljNusHQOhTM>

The Big Ideas

- How do you go from silica sand to a perfectly clear window? The main ingredient of glass is sand. It is mixed with soda ash and lime – sodium carbonate and calcium carbonate. This mixture makes glass easier to work with.

- The mixture is heated in conveyor belt oven up to 1650 degrees C. over three days. Over time, the mixture becomes like lava. For 10 hours, it is super-heated into liquid glass. Making glass requires a lot of heat energy.

- There is only one way to create plate glass that is flat on both sides without having any bubbles. Since 1959, glass makers have used a process where molten glass is poured on liquid

tin so it can become entirely flat. The glass cools over the liquid tin reaching 540 degrees C. over a 400 m process (nearly half a kilometre).

- The river of glass is cut into sheets of different lengths to make windows.

Worksheet - Rocks Around Home

Investigate the rocks around your home. For reference, look at <https://www.gravelfacts.ca/where-does-it-all-go>

Use the following sheet to record all the uses of rocks at home. Describe them.

- Look around the outside of your home for building materials: asphalt, brick, concrete.
- Look inside for how the home is finished: tiles, glass, mirrors, sinks and toilets
- Look at what you use every day: glassware, china plates, paper, paint
- Look at the labels on toothpaste, cleaning powders, cosmetics, chewing gum – look for: silica, calcium carbonate (limestone)



Sand 0.0625 mm - 4 mm		Gravel 4 mm and 75mm		Stone >75 mm
i. OUTSIDE	ii. INSIDE	iii. WHAT WE USE	IV. DAILY PRODUCTS	

Think About

1. Name one item from each column that requires stone, sand or gravel that surprised you. Why?

2. What would happen if we could not access stone, sand and gravel as raw materials? How would that affect our human-made environment? _____

3. The asphalt video shows how stone, sand and gravel are extracted. What are some environmental concerns we need be aware of in accessing these earth materials? _____

Look Locally

Visit local facilities that make bricks, asphalt or concrete to see the process in action. Or for home learning:

1. What was used to pave your driveway? Asphalt, brick or concrete? Who are the local suppliers of this material?

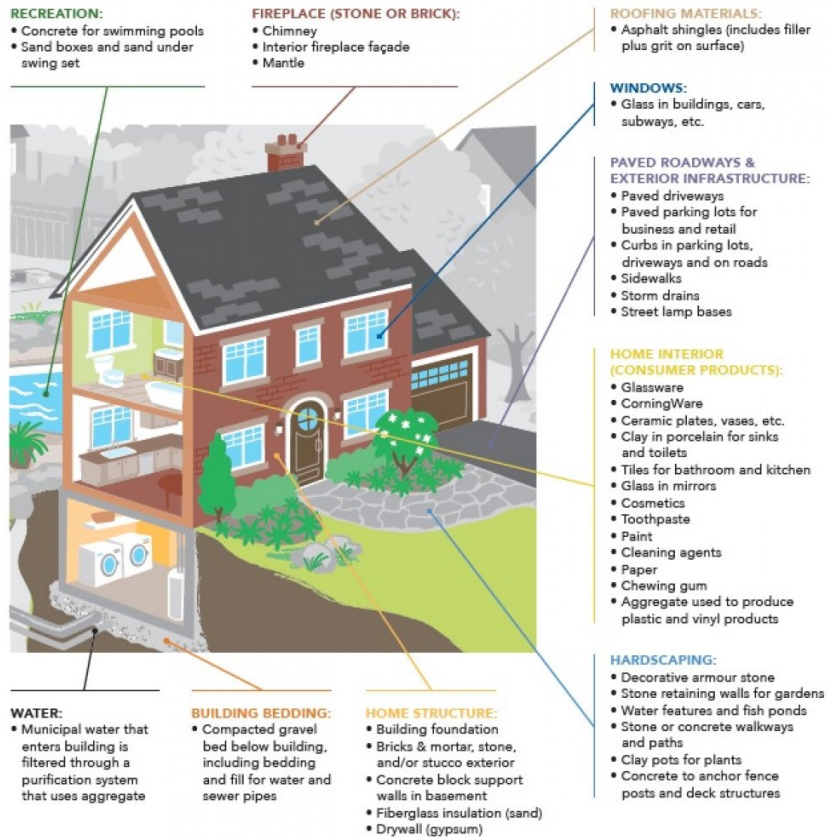
2. Over time, how has nature interacted with these materials? Draw a picture of what you observe in your driveway. Explain how they have become part of your home's ecosystem.

3. Are these materials long-lasting? Are they sturdy when compared to wood or plastic? Why is that important when constructing a home?

Where Does It All Go?

Suburban Environment

We all use stone, sand and gravel virtually every minute of every day. It's part of the buildings we live and work in, the roads we drive on... even the water we drink is filtered and purified by aggregate. It's used in everything from paper and paint to chewing gum and household cleansers.



LESSON 3 – ROCK SMART

Our rocky planet is made from three different types of rocks.

- cooled molten rock
- deposits from lakes and oceans; and weathering from rivers and streams
- pressurized and heated rock made from other kinds of rock

How can you tell the difference? Conduct this investigation. Become rock smart.

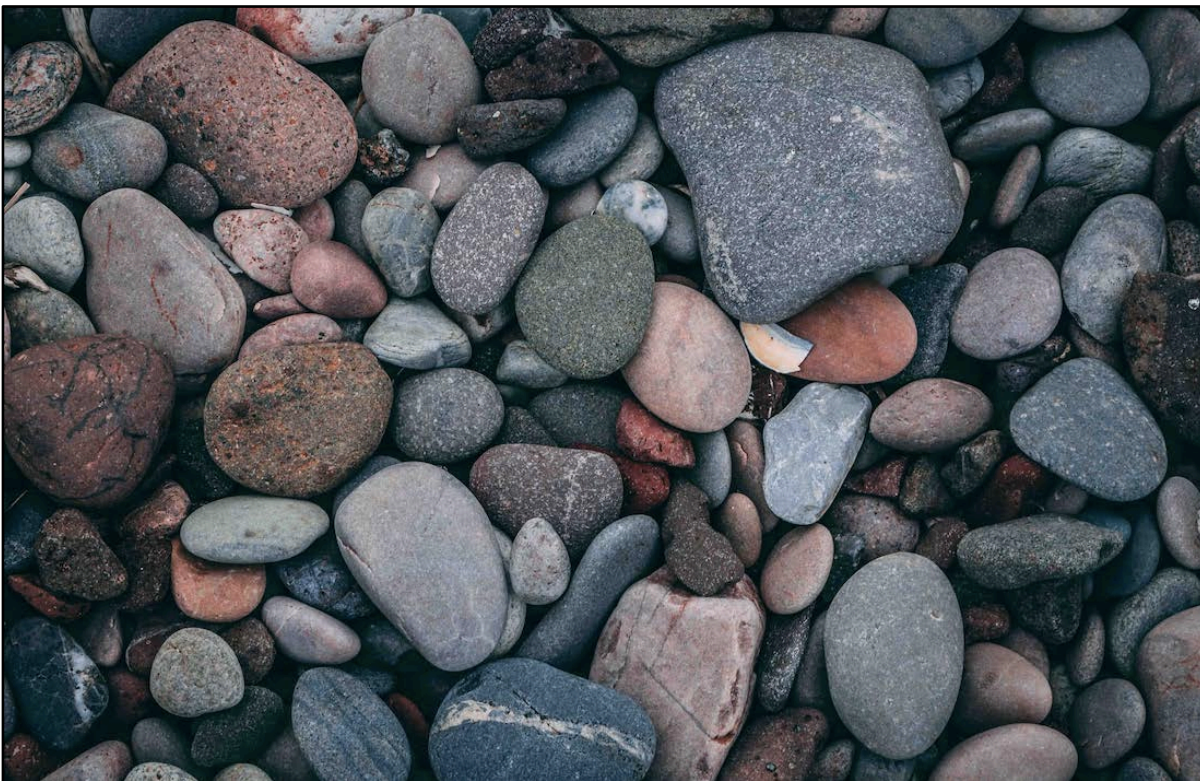
Investigation - Backyard Prospector

We have rocks outside around our homes. Collect a range of rocks from your backyard or local area.

Fill a small box with rocks that you think are unique or attractive.

Note where you found each rock: the garden, around the outside of the house, a local stream or vacant lot. Be safe. **ONLY COLLECT THE ROCKS WITH THE SUPERVISION OF A PARENT OR GUARDIAN.**

Now, let's find out what you found.



Test Your Rocks

Predict










Do you think that all the rocks you found are the same type of rock? Yes or no? _____

Explain why: _____

Materials

- the piles of stones sorted in the previous lesson
- a nail
- a copper penny
- a masonry drill bit
- diluted vinegar
- eye dropper

- the Mohs scale for hardness

Mohs Hardness Scale						
	Mineral Name	Scale Number	Common Object			
Increasing Hardness ↑		Diamond	10			
		→ Corundum	9	←		Masonry Drill Bit (8.5)
		Topaz	8			
		→ Quartz	7	←		Steel Nail (6.5)
		Orthoclase	6	←		
		Apatite	5	←		Knife/Glass Plate (5.5)
		→ Fluorite	4	←		Copper Penny (3.5)
		Calcite	3	←		
		Gypsum	2			
		→ Talc	1			Fingernail (2.5)

Procedure

1. Physical properties - Choose 8 to 10 of the largest stones from your assortment. Look for a range of different stones. Number each stone and identify its characteristics. Use the following descriptors. Add your own if they are different.

Property	Definition	Descriptors
Lustre	The way it shines or reflects light	Glitter, sparkle, sheen, gloss
Texture	How the quality of the surface feels	Rough, smooth, gritty, bumpy
Shape	A specific form	Round, oval, square, diamond
Size	Volume, dimensions	Small, large, pea size, wide, thin
Weight	Heaviness or mass	Heavy, light, medium
Colour	Colour of the light reflected	Tan, grey, white, pink, clear

2. Type of rock. Use this description to help you identify and describe your rocks.

- Igneous rock has random crystals and is heavy.

- Sedimentary – rub it to break off sand; see if it is easily breakable; look for stacks or layers in the rock.
- Metamorphic rock has crystals that are lined up; look for visible stripes, bands or rings.

3. Test each rock for hardness. Scratch each rock with a) your fingernail b) the penny c) the nail and d) the masonry drill bit. Record which one first makes a scratch. Use Mohs hardness scale to give it a hardness number. Record your results.

4. Use the eyedropper to put a drop of diluted vinegar on each rock. Record what happens.

Observations

Complete the following charts to record your test results.

1. Physical Properties

<i>Rock #</i>	<i>Lustre</i>	<i>Texture</i>	<i>Shape</i>	<i>Size</i>	<i>Weight</i>	<i>Colour</i>
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

2. To help identify the types of rocks in your pile, visit <https://geology.com/rocks/>

Hint: sedimentary rock usually reacts or fizzes when vinegar is dropped on it.

Record your observations in the table:

<i>Rock #</i>	<i>Type of Rock</i>	<i>Mohs Hardness Scale Number</i>	<i>Reaction to Vinegar</i>
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Conclusions

1. Did you find more of one type of rock than any others? Which one – igneous, sedimentary or metamorphic?

2. What does this tell you about the type of habitat or natural area your rock was found in? _____

3. What did you learn about how to identify rocks and minerals as a result of using the different tests? _____

Go Deeper

We learn about the history of our natural world through investigating rocks. Learn more about the rocks around you.

“Most of the solid surface of our planet (roughly 70%) is represented by sedimentary rocks, but if you go deep enough beneath the Earth’s surface, there are plenty of igneous and metamorphic rocks to be found.”

Source: <https://www.zmescience.com/science/geology/types-of-rock/>

The deeper rock is mined in quarries. Loose surface rock is mined in pits.

From what you know about how Earth was formed, why do you think this is so? _____

Look Locally

With a parent or guardian, collect rocks from other areas in your neighbourhood. Conduct the same tests on them. Are your findings the same as what you found in your backyard? Are they different? Are you near local landmarks such as streams, exposed bedrocks or cliffs? What does that tell about the natural history of your area?

Check out Making North America:

<https://www.pbs.org/wgbh/nova/assets/swf/1/explore-north-america/#/intro>

Click on the Menu and then Explore.

This interactive map allows you to explore landmark natural sites to find out how they were made.

Take the opportunity to visit a local quarry. Conduct a web search for the closest location and request permission. Many offer tours.

If in the area, contact British Columbia Stone, Sand and Gravel Association for more information:
<https://gravelbc.ca>



LESSON 4 – OUR CHANGING WORLD

It took over 4.6 billion years for our planet to form and change to this point. We can see this in how rocks are constantly changing.

Let's look at how rocks change.

Video Resources

Bill Nye does a great job of showing the different types of rocks and how they are formed.

Bill Nye – The Rock Cycle

https://www.youtube.com/watch?v=BsIHV_voMk

Watch the video stopping between the two segments – the rock cycle and types of rock. Pause the video after the first part.

Write some notes summarizing what you viewed.

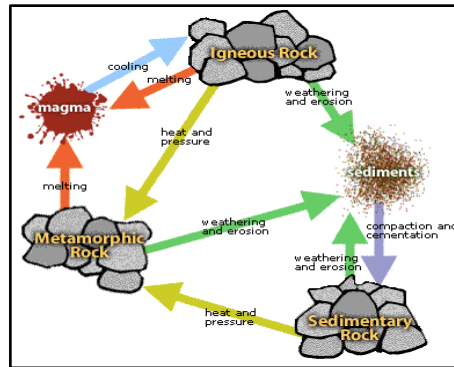
View the second part on types of rocks.

Review Lesson 1 on how to identify these rocks.

Investigation – Rock Changes

Rocks take thousands of years to change. How can you show how these changes work?

Here is a drawing that shows how:



Source - <https://www.nasa.gov/sites/default/files/rockingtherockcycle.pdf>

Show How

a) Tell or show the story of a rock. Use the rock cycle as your guide.

Start at any point in the cycle. Identify your rock, then explain how it changes from one form to another.

You can write this as a story or draw it as a comic.

b) You can show this physically. Here is one way. Take wax crayons apart and put them back together to simulate the entire rock cycle.

Materials

- 3-5 wax crayons (with paper wrapping removed)
- plastic knife
- aluminium foil

Procedure

1. The whole crayon represents an igneous rock.
2. To show weathering: shave the crayons with the plastic knife.
3. Demonstrate erosion: pick up the crayon shavings and move them to another part of your table
4. To show deposition, where rock pieces stop moving: spread the crayon shavings around; scatter them in various places
5. Rock pieces can be deposited underground, where compaction occurs. To show this put the crayon shavings onto some aluminum foil and fold into a packet.
6. Compaction forms sedimentary rocks: put the packet between your hands and apply light pressure.

7. Add heat and pressure to form metamorphic rocks: put the packet between your hands and apply heavy pressure.
8. Melting and cooling brings us back to the form of an igneous rock.

WITH THE HELP OF A PARENT OR GUARDIAN, melt the compressed crayon shavings.

NOTE: Crayons begin to soften at around 105 degrees Fahrenheit (40 degrees Celsius) and they have a **melting point** between 120-147 degrees Fahrenheit (49 – 64 degrees Celsius)

Two safe ways to melt the crayon in the aluminum foil packet:

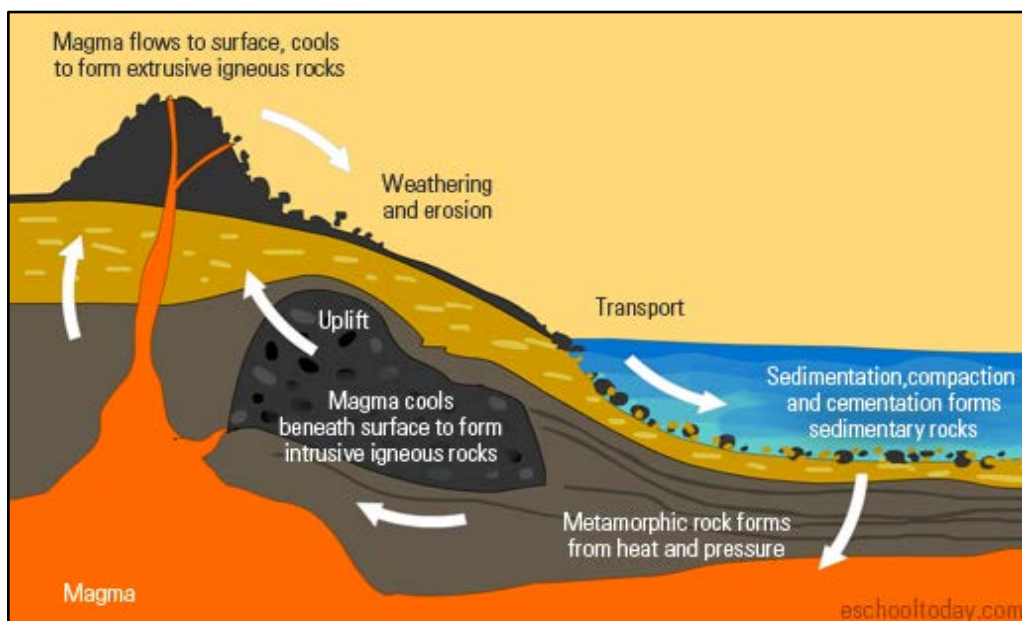
- 1) place the foil packet in a small pot of just boiled water. Turn off the heat. Let the hot water melt the crayons.
- 2) use a blow dryer on high heat to melt the crayon shavings.

DO NOT PUT THE ALUMINUM FOIL PACKET IN THE MICROWAVE!

Extension

Explore different type of igneous rock. Pour the melted crayon:

- over ice cubes to form "pumice," (<https://mineralseducationcoalition.org/minerals-database/pumice/>)
 - into ice water to form "obsidian," (<https://mineralseducationcoalition.org/minerals-database/obsidian/>) or
 - over warm or hot water to form igneous rocks, such as "diorite" (<https://mineralseducationcoalition.org/minerals-database/diorite/>) and granite." (<https://mineralseducationcoalition.org/minerals-database/granite/>)
- Adapted from - <https://serc.carleton.edu/sp/mnstep/activities/34972.html>



Source: <https://eschooltoday.com/learn/the-rock-cycle/>

Definitions

Look at the diagram of the rock cycle. Define the terms and describe where the following occur in the cycle.

- weathering _____
- erosion _____
- deposition _____
- cooling _____
- melting _____
- pressure _____
- compaction _____
- cementation _____
- heat _____

Conclusions

1. What will you remember most from learning about the rock cycle? _____

2. Granite is the most common igneous rock. It underlies most of the continent of North America. (It is the most common construction aggregate in British Columbia.) Have you seen granite used in homes? Where and how? _____

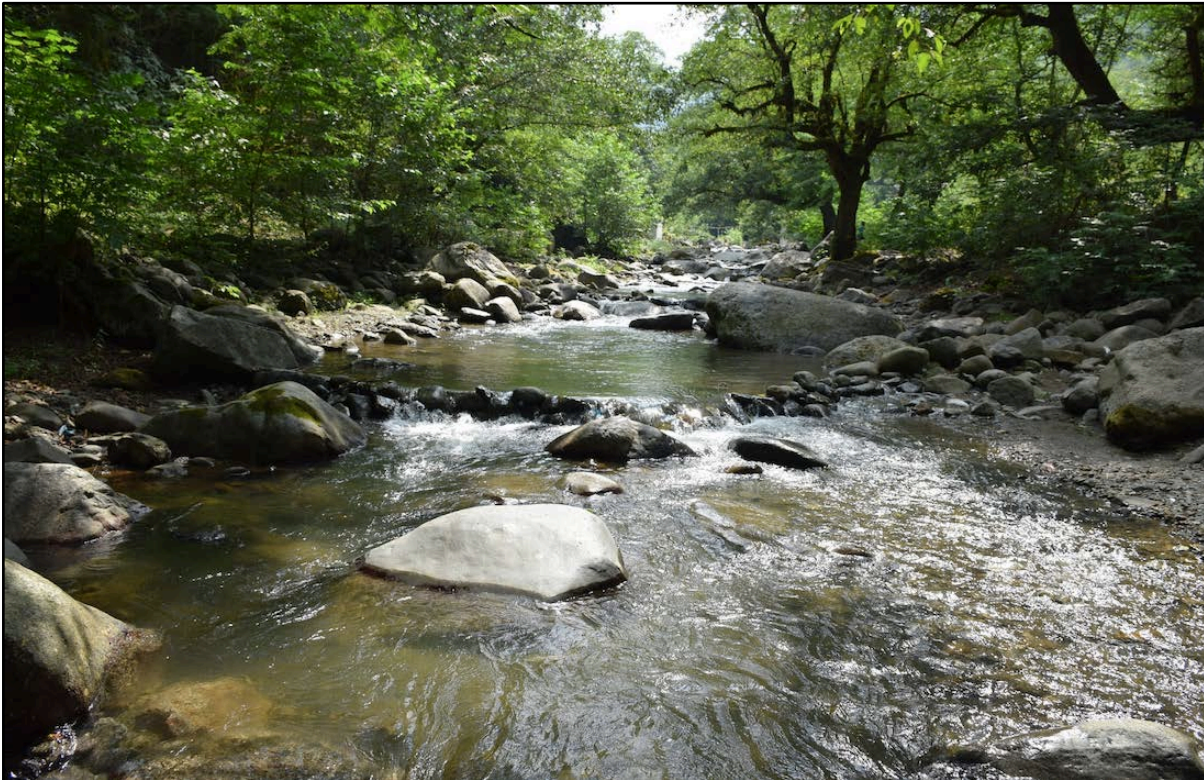
3. Limestone is the most common sedimentary rock. It is the main material used in construction. It is used to make paper, plastics, glass, paint, gravel, steel, cement, carpets, and building stone; it is used in water treatment and purification plants and in the processing of various foods and household items (including medicines).

List three things in your home that used limestone:

1. _____
2. _____
3. _____

Look Locally

Explore a local conservation area or park where you can observe rocks undergoing change: in a stream, erosion down a hill, on a shoreline or wherever there is exposed bedrock.



LESSON 5 - LOCAL EARTH MATERIALS

Rocks are resources. We use stone, sand and gravel to construct our roads and communities. Where do these resources come from?

Rock Facts

Aggregate is the technical term for stone, sand and gravel. Sand and gravel come from pits; stone from quarries. What's the difference between a pit and a quarry?

A pit is where the sand and gravel are loose. It can be easily accessed once the top layer of soil is removed, or it can be dredged from sandy deposits in rivers.



A quarry is where the stone has to be blasted apart or cut using giant saws. This is typically igneous rock like granite. Quarries are also located close to the surface. In fact, many rarely reach a depth greater than 100 feet.



Like other types of rocks and minerals, aggregates are only found in places where nature put them.

60% of the cost of aggregate is transportation. Most of these earth resources are used in larger cities, so it is most sustainable to find a pit or quarry closest to where the aggregate is being used.

Stone, sand and gravel are heavy. Moving them requires the use of fossil fuels, which emit carbon dioxide and other air pollution. The greater the distance aggregate needs to be moved the greater the use of fuels - the greater the cost and the greater the emissions.

Natural Deposits

Natural deposits of loose stone, sand and gravel occur as a result of melting ice or flowing streams or rivers.

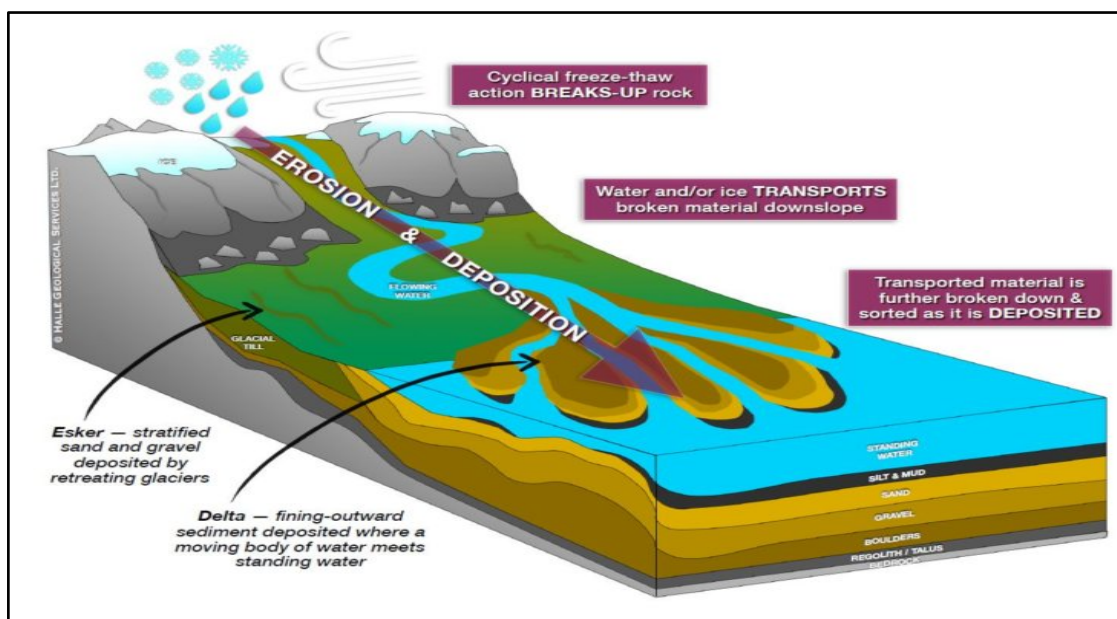
When a glacier melts, it leaves behind a **moraine** – loose stone, boulders, sand and gravel that it ground up and pushed to the front and side

Inside a glacier, melting ice forms rivers. **Eskers** are the banks of sand and gravel left behind from the erosion caused by the flowing water.

Alluvial fans are the deposits of sand and gravel at the mouth of rivers.

These natural processes provide the sites for pits, where stone, sand and gravel can be dug up for use in constructing our communities.

The common element in all these processes? Flowing water that causes erosion and deposition of rock.

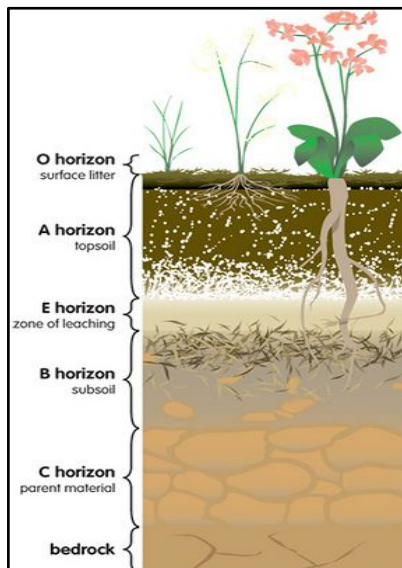


Sand and gravel are available in or near the rivers or creeks. Stone can be mined in the hillside. Each has its own ecosystem.

INVESTIGATION - ROCKIN' YOUR YARD

The natural world of rock resources is right under our feet.

Here's a typical cross-section of the soil in a backyard or park.



SOIL JAR TEST

Find the stone, sand and gravel in your backyard or local park. Conduct a soil test.

Materials

- a 16 oz. (1l) mason jar with screw-on lid
- permanent marker
- watch
- 1 teaspoon (5 ml) of dishwashing detergent

Procedure

1. Collect a soil sample. With the help of a parent or guardian, use a hand trowel to dig a small hole in your backyard (or at the edge of a local park, field or grassy verge, somewhere it is safe and permissible.) Try to dig as deeply as you can while not widening the hole.

Dig below the root line of the plants. The soil sample should include clay, rocks and sand.

2. Mix the soil sample so it is a consistent mixture of all the elements of the soil.

3. Measure 2 cups (500 ml) of the mixed soil and place it in the jar.

4. Fill the jar with clean water, leaving a little space at the top.

5. Add 1 teaspoon (5 ml) of dishwashing detergent.

6. Screw the lid on the jar and shake vigorously until it is uniform “mud shake”.
7. Place the jar on the table. Observe what happens. After one minute, write down your observations. What do you see happening in the jar?
8. Leave the jar in one spot for two hours. Observe what happened. Write down your observations.
9. If distinct bands have appeared, mark them with the permanent marker.
10. Leave the jar overnight. Observe what happened. Write down your observations.

Observations

1. After one minute, I observed _____

2. After two hours, I observed _____

3. After waiting overnight, I observed _____

4. What kind of organisms did you observe in the mixture? _____

Conclusions

1. What did this investigation show you about what's in your local soil? _____

2. If you found sand in your soil, what does that tell you about the natural processes that created that soil? _____

3. Sand is associated with what type of rock? _____

4. Would you call your soil rocky, sandy or mostly clay? _____

5. What does that tell you about the natural habitat of your area? _____

Investigation - Erosion in Action

Build a 3D model that simulates how erosion creates alluvial fans for sand and gravel resources.

Research Questions

How does the force of moving water cause erosion?

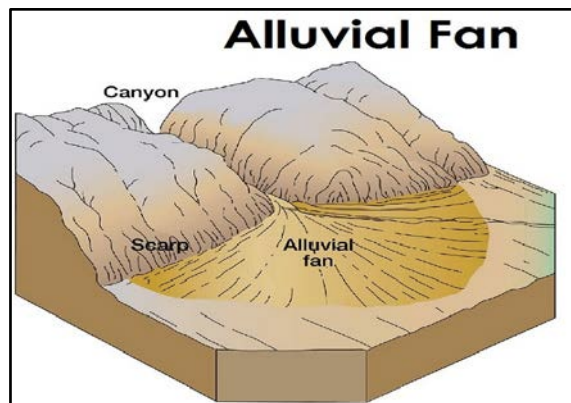
Why does the eroded material fan out when it is deposited?

Materials

- a clear plastic storage container
- different sizes of pebbles – large and small – separated out (available from a hardware or aquarium store)
- sand
- dirt
- cup of water
- eyedropper

Procedure

1. Build a slope of the largest stones in the plastic container to form a hill at one end and a lake at the other.
2. Build up the layers of stones with the largest stones at the bottom and the smallest stones on top.



3. Add a layer of sand on top of the stones. Add a sprinkle of soil on top of the sand
4. At the top of the "hill", use the eyedropper to start a flow of water down the centre of the sand.
5. Slowly add more water to the same location, creating a stream of water down the centre of the hill.
6. As the water starts to reach the bottom of the hill, in the space when a "lake" forms, observe what happens.
7. Use as much water as needed to create a deep trench where the water flows. Observe the end result in the lake area.

Observations

1. What is the effect of the running water on the hill? _____

2. As more water runs down the hill, what happens at the bottom of the hill? _____

Conclusions

1. How do the forces of nature help us access sand and gravel resources? _____

2. How does this model show the action of erosion and deposition? _____

Look Locally

a) Use Google maps to locate where you live. Zoom out until you locate nearby pits and quarries.

b) Conduct a search. Use the key words: local pits and quarries. Identify their location.

How close are they to your community? What is benefit of having a pit or quarry close by?

c) Go to the web site of the local pit or quarry you have identified. Collect any photographs that show how it operates.

What kind of rock products do they provide?

What does that tell you about the natural history of your area?



LESSON 6 – SUSTAINING OUR EARTH

Our Earth is our only home. We have to do everything we can to use our resources carefully and always support nature's way of restoring itself.

Removing stone, sand and gravel from pits and quarries has environmental impacts. There are several ways to limit these impacts.

Pits and quarries are closely monitored for their impact on the land – changes in habitat, species at risk, water use and noise.

Moving the rock is done in the most sustainable way - the closer the pit or quarry is to the construction, the less the amount of fuel needed to move the rocks.

Rehabilitation of the sites is planned from the start.



A gravel pit near a community under construction.

Moving Rock

A big challenge is moving the rock from where nature deposited it to where we want to build our communities.

Stone, sand and gravel are extremely heavy. They are measured in tons (tonnes). The average gravel truck carries 22 tons (20 tonnes).

What's the most sustainable way to move rock in your area?

Questioning and predicting

Name three different modes of transportation in your area.

1. _____
2. _____
3. _____

Predict the most sustainable way to carry rock.

List three questions you have about moving rock from a pit or quarry to a construction site.

1. _____
2. _____
3. _____

Planning and conducting

Explore your local pit or quarry.

Find the closest pit or quarry on Google Maps. Zoom into the site.

- How far away is it from your community? _____ miles (km)
- What is the name of the facility? _____

Visit the web site of the stone, sand and gravel provider. Look for pictures or videos of their operations.

What did you find most interesting? _____

Best Routes

Check out the local pit or quarry on the map again.

Look for the closest route to move the rock to your community.

Which is closest to your local pit or quarry?

- a roadway: _____
- a railway: _____
- a river or lake: _____

If you can, print out the map. Draw what you think is the best route to move the rock to your home.



Moving rock often requires two modes of transport.

LESS IS MORE

Most of the cost for stone, sand and gravel is for transportation. If we can travel less, all of the costs are lessened. When we lower transportation costs, we lower environmental costs.



Large gravel trucks sometimes use tandem trailers.

Math Activity – How Far is Too Far?

We want to minimize the environmental consequences of transportation. And yet our communities need the stone, sand and gravel from pits and quarries.

Moving rock requires energy. Every mode of transport uses a fossil fuel – most often, diesel fuel.

Burning fossil fuels produces CO₂ – a greenhouse gas that contributes to global warming and climate change.

The less fuel burned to move the rock; the lower the environmental impact. There are two ways to reduce the use of fuel:

- reduce the distance travelled
- use modes of the transport that burn less fuel.

Explore this relationship. Complete the following worksheet to investigate.

Worksheet – How Far is Too Far?

“Payload distance” - how far a vehicle travels carrying a certain mass is measured in tons per mile in the US and tonnes/kilometre in Canada and Europe.

For each unit of mass/distance, a certain amount of energy is required to move the rock. Here is the amount of carbon dioxide (CO₂) emitted:

- A freight train emits an average of 32g CO₂/ton-mile or 22g CO₂/tonne-km.
- A barge on inland waterways emits an average of 45g CO₂/ton-mile or 31g CO₂/tonne-km
- A gravel truck emits an average 91g CO₂/ton-mile or 62g CO₂/tonne-km.

Do the math. Complete the table with your calculations.

Name of Pit or Quarry	Distance to Town (miles/km)	Barge (g. CO ₂ /ton/mile or tonne-km)	Rail (g. CO ₂ /ton/mile or tonne-km)	Truck (g. CO ₂ /ton/mile or tonne-km)
1.	100 miles/160km			
2.	50 miles/80 km			
3.	10 miles/16 km			

Evaluate and Draw Conclusions

Think about the environmental impact of moving the rock.

The location of a pit or quarry depends where nature deposited the rock.

How we move the rock depends upon how close the location is to the community and the availability of roads, railways or rivers that are close by.

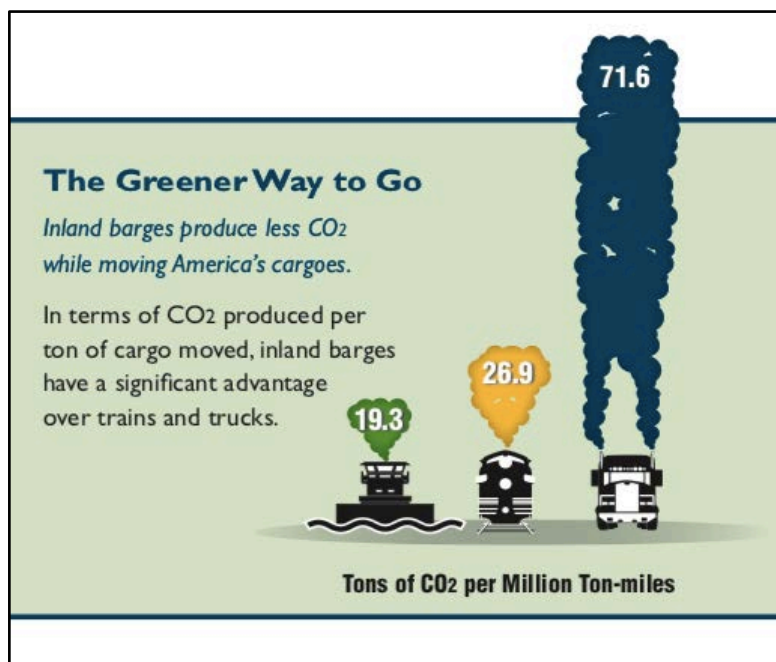
1. If there is no river nearby, what kind of transportation choices do we have?

2. If there is no river or railroad nearby, what kind of transportation choices do we have?

3. How does the amount of fuel used to move the rock affect the environment? _____

Extension – Media Literacy

In this infographic, CO₂ emissions are presented to support an argument for using one form of transport over the others. Use your critical thinking skills to detect what it is trying to tell you and why.



Source: Texas Transportation Institute, Center for Ports and Waterways.

1. Which way to move rocks does this graphic prefer? _____
2. Why do you think this is so? _____
3. Is it always possible to move rocks this way? Why or why not? _____
4. Why do we need all three forms of transport to move stone, sand and gravel? _____

Communicate – Assessment

Write what you learned about how decisions are made about moving rocks from pits and quarries to our communities. Use these questions to guide you.

- Why is it necessary to gather data?
- How does the data help you make decisions?
- How does this help you determine the trade-offs between extracting earth resources and protecting the environment?

LESSON 7 - BORROWING THE LAND

Quarries and pits are used for a short period of time.

After the stone, sand and gravel are removed from a pit or quarry, the site is returned to one of a wide range of end uses: wildlife habitats, wetlands, recreational parks, forestry or farmlands.



Reclaimed

Explore some of the ways the land from a pit or quarry can be reclaimed. Take a look at the following four examples. Click on the before and after pictures. Explain how the land was reclaimed.

1. CalPortland

<https://mineralseducationcoalition.org/reclamation-stories/calportland/>

2. Beckman Quarry

<https://mineralseducationcoalition.org/reclamation-stories/beckman-quarry/>

3. Louisville Mega Cavern

<https://mineralseducationcoalition.org/reclamation-stories/louisville-mega-cavern/>

4. Investigate the transformation of a quarry into the famous Butchart Gardens. Visit

<https://www.butchartgardens.com/our-story/>

If you visited any of these reclaimed sites today, could you tell if this was once a pit or a quarry? Why or why not?

How Land Is Reclaimed

Boxley Creek – Washington State

We borrow the land to access earth resources. Then we return it to become a local habitat.



Ground prepared for reclamation.



The contours of a creek in place.



creek carving its own path.



Vegetation starting to grow.

The



Local habitat springing up.

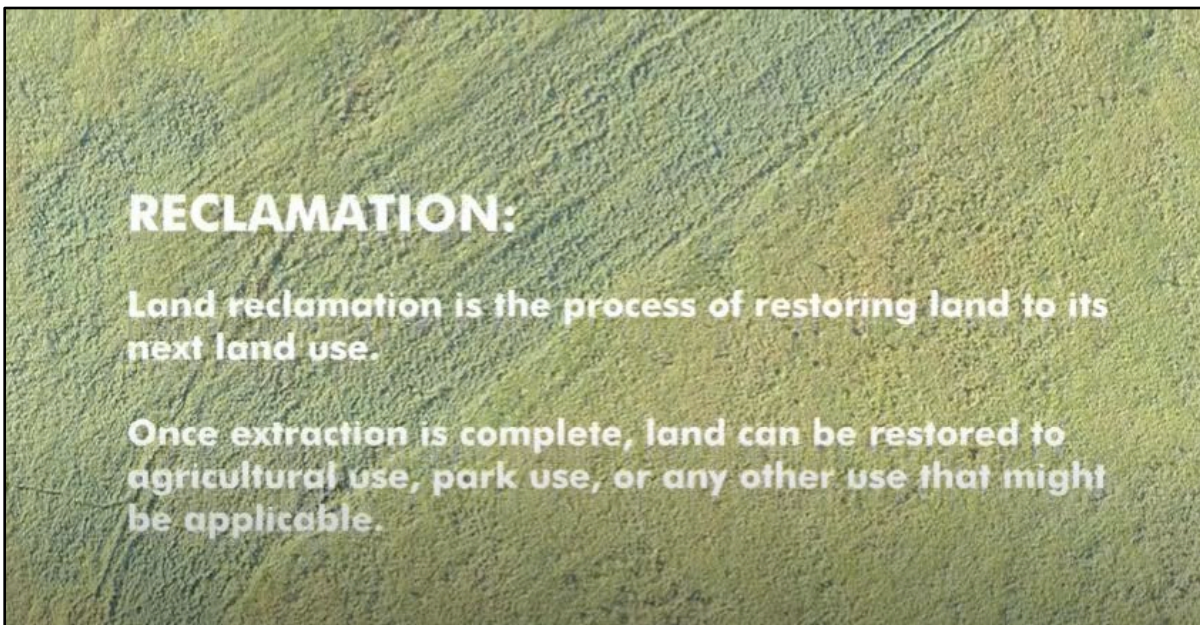


The creek today fully reclaimed.

Worksheet - Reclaiming the Land

View the video of how one stone, sand and gravel company reclaimed the land it was using.

In some places, the land is being reclaimed while it is being worked.



Valley Gravel Sales Ltd - Land Reclamation

https://www.youtube.com/watch?time_continue=16&v=1la_sPbf3hs&feature=emb_logo

What is the most memorable thing this video told you about how land is being reclaimed?

Be a Reclaimer

Find one of the pits or quarries closest to you. Use Google Satellite Maps.

Zoom into the map to see the features of this pit or quarry.

- How large is it?
- Is it shallow or deep?
- How much of a lake is there? Is it large?
- What are some of its most striking features?

There is a difference between a pit and quarry. The way it can be reclaimed will differ too.

For example, if there is a deep lake left over from the excavation, what could it be used for? ____

What about a vast area that was a not-very-deep gravel pit? What could that be used for? ____

Think It. Plan it. Draw it.

You are in charge of reclaiming a pit and/or quarry closest to your community.

Determine the most useful purpose for the land. Here are some examples:

1. An undisturbed wild area (forest)
2. A lake, river or pond
3. Grasslands
4. A farm
5. Homes – a residential neighbourhood

Think about or research important species in your area. What kind of habitat do they need?

How could this pit or quarry help support any of these species? _____

Design the finished project. To design the reclaimed local pit/quarry, consider the following:

- Depth of the pit or quarry
- Water
- Surrounding Lands
- Community Needs
- Species who could use the habitat (pollinators for local flowers; trees for bobcats.)
- Local industry

Choose your favourite art form: drawing, painting, digital art, collage, etc.

Using the outline of the pit or quarry from the satellite image, draw your vision of what this reclaimed pit or quarry could be.

When you have completed your artwork, write a paragraph about the best features of your reclamation project, and how it will suit the needs of the surrounding ecosystem, local species and community.

Look Locally

Explore local historical sites that have been reclaimed from a pit or quarry.

Look at local online archives to see how stone, sand and gravel was extracted to build your community. Use the local library or city hall. Speak to local historical associations.

Research its current use: an attraction (gardens), park or recreation site, a conservation area, etc.

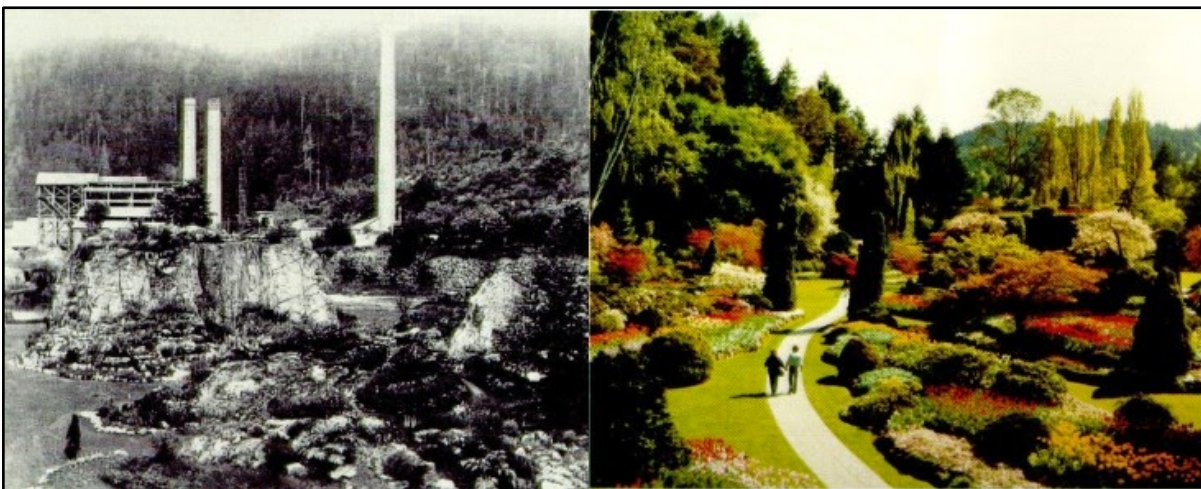
Look to the Future

How can we balance our increasing need for stone, sand and gravel while balancing the need for environmental stewardship?

Research new technologies to meet this demand, such as “living concrete” to reduce CO₂ impact.

<https://www.businessinsider.com/living-brick-material-bacteria-regenerates-2020-1>

How does this innovation help balance the protection of the Earth with our need to extract stone, sand and gravel? _____



Reclaimed quarry becomes Butchart Gardens.

EXTENSION - BE AN EARTH SCIENTIST

Investigating the birth of the Earth helps us understand the uniqueness of our planet; how it provides all we need to build our lives, *if* we take care of it,

How do we prove the theories about how the Earth was formed?

Watch this video. It profiles eight scientists who are working to prove how the Earth was born 4.6 billion years ago.

Naked Science - Birth of the Earth

<https://www.youtube.com/watch?v=XYHe5wQeA28>

List three new things that you learned from the video:

1. _____
2. _____
3. _____

Go Deeper

How did nature build an Earth for humans to live?

Choose one of the letters below corresponding to the theory and scientist you wish to explore in depth. Watch that specific segment of the video. Summarize what you've learned. Think about how you could demonstrate how this works.

A. How a vast cloud of gas, sand and dust in space came together under the force of gravity to form our sun and solar system. (Time 2:18)
Astronomer, Dr Tom Fleming, The University of Arizona

How did this work? _____

How did Tom demonstrate how our solar system evolved? _____

What is another way to demonstrate this? (Think about sports or what you have experienced in a playground.) _____

Conduct your demonstration. Explain what happened. _____

B. How the dust circulating the sun was turned in our planet 4.6 billion years ago. (Time 6.26)
Astronaut, Dr Stanley Love, NASA

How did this work? _____

How did Stan use the space stations videos to prove how planets form? _____

How can you demonstrate this on Earth? Watch the video closely for clues. _____

Conduct your demonstration. Explain what happened. _____

IDEA: Use cereal science to show how objects clump together. Have a bowl of Cheerios or similar cereal in milk. As you get down to the last few bites, observe what happens to the remaining Cheerios floating in the milk.

What did you see happening? _____

Place a single Cheerio in a bowl of milk. What does its weight do to the milk beneath it?

Place a second Cheerio in the bowl. Allow the two Cheerios to drift close to each other. Describe what happens. _____

NOTE: they will appear to "fall into" one another, as if pulled together by an attractive force. How does this show how planets form? _____

C. How the Earth has been protected from solar (Sun)storms and why this is necessary for life on Earth. (Time 8.53)

Dr. Rodney Viereck, Space Environment Centre

How do storms on the sun affect us on Earth? _____

What damage can solar winds do to a planet? _____

Where has this happened? _____

How does our atmosphere protect us? _____

D. How does the Earth survive solar winds and keep its atmosphere? (Time 14:20)
Dr Daniel Lathrop, University of Maryland

What makes up the Earth's core? _____

How does the Earth's core protect our planet from solar winds? _____

What is a dynamo? _____
How can you demonstrate the dynamo action of the Earth's core? _____

Conduct your demonstration. Explain what happened. _____

IDEA: Build a model of the Earth's core. You'll need:

- a large nail
- a length of wire
- a battery
- paper clips.

Wind the wire tightly around the nail, leaving some of each end of the wire free to connect to the battery. Connect the wound wire to the battery. Place the paper clips nearby.

Observe what happens. How does this show the action of the Earth's core?

Explain how the northern and southern lights prove how the Earth's magnetosphere protects life on Earth. _____

E. How the creation of the moon tells us how the Earth evolved. (Time 20:08)
Dr Robin Canup, Southwest Research Institute

How was the moon created, according to Robin's research? _____

What were the two major effects on Earth of the creation of the moon? _____

When the moon was created, the Earth was tilted on its axis. The tilt of Earth's axis is about 23.5 degrees.

"Earth's tilted axis causes the seasons. Throughout the year, different parts of Earth receive the Sun's most direct rays. So, when the North Pole tilts toward the Sun, it's summer in the Northern Hemisphere. And when the South Pole tilts toward the Sun, it's winter in the Northern Hemisphere."

- <https://spaceplace.nasa.gov/seasons/en/>

Imagine what our lives would be like without the seasons. Write a paragraph about a day in the life of a "world without seasons."

F. How the Earth got its water, which is needed for life. (Time 27:27)
Dr Michael Zolensky, NASA

What did Michael find out about what is in a meteorite? _____

What is Michael's theory about how the Earth got its water? _____

How does this differ from the theory shown in the first, shorter video? _____

What does this tell us about how our knowledge about our planet changes, just as our planet itself is changing? _____

G. How do we prove the theory of how the Earth got its water? (Time 38:16)
Geologist, Dr Stephen Mojzsis, University of Colorado

What did Stephen do to find out when the Earth got its water? _____

4 billion years ago, our early oceans were rich in iron. The sky was thick with methane.

Paint, draw or colour a landscape of our early Earth showing what it looked like. Use the colours of the iron ocean and methane skies.

H. How did the Earth get its oxygen? (Time 41:20)
Geologist, Dr. Martin Van Kranendonk, Geological Survey of Western Australia

Explain Martin's theory about how the Earth got its oxygen. _____

What are stromatolites? _____

How did the oxygen produced by the stromatolites change the iron oceans and provide the building block for life on Earth? _____

What is a way to demonstrate this? (Think about how plants use chlorophyll to convert carbon dioxide into oxygen. How can you show that this happens?) _____

Conduct your demonstration. Explain what happened. _____

IDEA: Here's one way to show how plants emit oxygen. Use a small aquatic plant – a green one you would put in an aquarium or find in a pond. Put it in an 8 oz. (250 ml) jar. Fill the jar with water. Fill a 16 oz (500 ml) jar half full of water. Put the small jar inside the large jar, trying to keep the small jar as full of water as possible. Put in the light. Observe what happens over a few days.

What happens to the water in the small jar? What is it filling up with?

Explore Earth

Visit NASA Science Solar System Exploration to learn more about our planet.

<https://solarsystem.nasa.gov/planets/earth/in-depth/>

