

Designation: Ontario Curriculum: Science and Technology



Earth and Space Systems: Grade 4 – Rocks, Minerals, and Erosion

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Specific Expectations Addressed:

Understanding Basic Concepts – identify and describe rocks that contain records of the earth’s history (e.g. fossils), and explain how they were formed

Developing Skills of Inquiry, Design, and Communication – formulate questions about and identify needs and problems related to objects and events in the environment, and explore possible answers and solutions (e.g., create a mould of a fossil and use the mould to make a replica of the fossil to demonstrate how the fossil was formed; design and carry out an investigation using sand structures to show the relationship between volume of water and erosion)

Relating Science and Technology to the World Outside the School – conduct their investigations of the outdoor environment in a responsible way and with respect for the environment (e.g. leave the site of the investigation as they found it, putting back objects examined where they found them and taking away all equipment brought to the site).

Background:

Fossils Facts and Evidence of Erosion

A fossil is a remnant or trace of an organism, found in sedimentary rock, from a past geologic age. The fossil is either a skeleton, footprint, or leaf imprint, which are termed Solid Fossil, Trace Fossil, and Imprint Fossil. It should be logical to students who have already studied the three types of rocks that fossils form as they are covered in layers of sediment, therefore becoming part of sedimentary rock.

Fossils are formed over millions of years: it takes time for the plant or animal to be buried, decay, and especially for the sediment (sand, rock particles) to turn into stone. Paleontology is the study of these fossils, which tells us much about how life evolved, both in the sea and on land. Fossils also help describe the environment the plant or animal lived in, and help to date the rocks they are found in.

Erosion is both a natural process and an unfortunate result of human activity. Natural erosion is caused by weathering, dissolution, abrasion, and corrosion. These natural processes all involve transport of material (typically soil or sand) in which earthy or rocky material is removed from the earth’s surface.

Soil erosion is a very serious problem all over the world today. When soil components, especially topsoil, move from one area to another this is either natural or human-accelerated soil erosion. The two main forces causing soil erosion are wind and flowing water. This is a natural erosion process and plant roots or trees are generally protective of excessive soil erosion. However, when humans disturb the environment with agriculture, logging, construction, and other human activities which destroy the flora and fauna (plant cover) it greatly accelerates the rate of soil erosion. We learned in the Grade Three science “Soils in the Environment” section that one inch of soil takes from 200 to 1000 years to renew itself. Therefore, since annual erosion rates for agricultural and construction areas are very high, they actually exceed the earth’s ability to replace the lost soil.

Erosion along the earth’s shorelines is slightly different. This is an inevitable and natural process as the flow of water, wind and waves results in the transport of sand, gravel, rocks, and boulders. Shorelines are highly varied in their form: lakeside beaches are *formed by the deposit*, or deposition, of materials eroded from other areas, such as depositions of sands, gravels and rocks. These shores are typically sheltered and not exposed to extreme weather and water movement such as those found on sea and ocean shorelines.

In these other (sea/ocean) shoreline environments, near rocky headlands or cliffs, where sedimentary material is scarce and where there is high wave energy, water and waves *transport material away* and the coastline is eroded. Human activity causes shoreline erosion, too. Teaching students to respect and help retain original shorelines is one way to combat this problem. This activity takes students to the shore to do so!

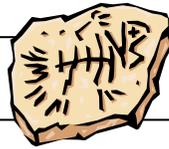
Procedure:

Part 1

Understanding Basic Concepts – identify and describe rocks that contain records of the earth’s history (e.g. fossils), and explain how they were formed

Developing Skills of Inquiry, Design, and Communication – formulate questions about and identify needs and problems related to objects and events in the environment, and explore possible answers and solutions (e.g., create a mould of a fossil and use the mould to make a replica of the fossil to demonstrate how the fossil was formed; design and carry out an investigation using sand structures to show the relationship between volume of water and erosion)

Imprint in Time: Making a Fossil Imprint



Materials Needed For Activity:

- plaster of Paris package
- non-hardening modelling material
- water
- fork
- plastic tub
- strip of scrap construction paper / Bristol board
- paper clip
- squares of waxed paper
- seashell (or other item of distinct shape) DECIDE: one per student or one demo made by teacher?
- wooden board / cutting board
- hammer and chisel
- safety glasses

- 1) Mix up a tub of plaster of Paris and water, following the instructions on the package.
- 2) Use the construction paper / board to make a circle or collar by paper clipping one end to the other
- 3) Place paper collar on top of one square of waxed paper and fill the circle $\frac{1}{2}$ full of modelling material
- 4) Press the seashell or object into the centre of the clay
- 5) Cover over the shell with plaster of Paris
- 6) Let plaster dry for at least half an hour. Teacher may now crack open the rock to remove the shell / object, wearing the safety glasses and using the hammer and chisel.
- 7) Observe the imprint left behind once the shell is removed
- 8) Based on students’ knowledge of sedimentary rock ask the following questions:

Explain HOW a fossil imprint is created naturally...

Answer: Just as sediment settles over time and with pressure to create rocks, the same sediment may settle around a dead animal or plant. It also becomes rock but it contains an organic object which will rot away eventually and leave its imprint. This fossil imprint, which took thousands of years to form, is therefore a wonderful record of the earth’s history. Scientists called paleontologists can study the shape / outline of the plant and “see” what life-forms existed long ago. Paleontology, or the study of fossils, also discovers clues about the environment the fossil creature once lived in and can also help date rocks. Paleontology pieces together all of these clues to tell a story about the evolution of life on land and in the oceans.

Why are the fossils of sea creatures most often found?

Answer: Their bodies were designed to survive in water! Their (often) hard-shelled bodies cannot decay completely underwater. Fossils have been found from sea creatures that lived 60-400 million years ago!



Materials Needed For Activity:

- plaster of Paris package
- modelling material
- water
- fork
- scrap paper
- rolling pin
- sea shell (or other item of distinct shape) DECIDE: one per student or one demo made by teacher?
- petroleum jelly (Vaseline)
- strip of scrap construction paper / Bristol board
- paper clip
- glass jar

- 1) Use the scrap paper as a work surface to protect the desk
- 2) Use the rolling pin to roll out a ball of modelling material into a flat circle, approximately 2cm thick
- 3) Press your shell or other object deep into the modelling material. Deep enough that it leaves a clear impression but not deep enough to settle all the way down to the paper
- 4) Remove the shell carefully without changing its imprint
- 5) Rub the jelly inside the imprint and all over the clay circle or new “mould”
- 6) Make another paper circle or collar (as above) and fasten with paper clip, press this into the mould centering around the shell imprint
- 7) Mix some plaster of Paris in the glass jar and then pour it into the collar on top of the mould, leaving it to set for half an hour
- 8) Very carefully, remove the solid plaster from the mould. Again, we have a fossil imprint in the mould and now we also have a solid fossil in the hard plaster form
- 9) Based on students’ knowledge of rocks and minerals ask the following questions:

How is it possible to create a solid fossil? Don’t the animals or plants rot away and just leave an imprint?...

Answer: If all rocks consist of one or more minerals, it’s the minerals which are replacing the skeleton! It’s the same process as above: an animal or plant dies and settles into sand at the bottom of an ocean or into mud on land. If the body is buried quickly, it is protected from being eaten and it may form a fossil. The sediment settles around it and a sedimentary rock begins to form. Eventually, the soft parts of the body rot away, but the bones, teeth, shells or the plant’s leaves or woody parts remain. After an even longer time than a fossil imprint takes to form, these hard parts are replaced by minerals like calcite, pyrite or quartz. This is the solid fossil we created in plaster!

Which type of fossil (imprint or solid) would you rather study if you had to describe a plant or animal from long ago? Why?

Why is paleontology so important in learning about the earth’s history?

Using fossil samples provided by your teacher or fossils that you have collected at home, record the following information:

	Fossil of Sea Creature	Fossil of Plant	Fossil of Land Animal	Mystery Fossil
COLOUR OF FOSSIL ROCK				
SHAPE OF FOSSIL ROCK				
TEXTURE OF FOSSIL ROCK				
MEASUREMENT OF PLANT/ ANIMAL				
Describe how the LIVING plant or animal would have appeared...				

A fossil is a _____ (rock / gemstone) that contains the preserved mineral remains or the imprint of a once-living animal or plant.

These rocks, or fossils, are formed when an animal or plant is buried in _____ (salt water / sediment). Therefore, fossils are found in _____ (igneous / sedimentary) rocks.

The soft parts like _____ (skin / teeth) rot away, but hard parts like _____ (eyes / bones) remain.

Dinosaur fossils are very exciting to study because today dinosaurs are _____ (rare / extinct) and this is the only way to study what they used to look like and where and how they lived.

<p>Can you guess: If an animal leaves a <i>trace</i> of its path or footprints behind, what kind of fossil does that create?</p> <p style="text-align: right;">Answer: A Trace Fossil!</p>

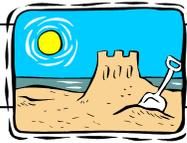
Procedure:

Part 2

Developing Skills of Inquiry, Design, and Communication – formulate questions about and identify needs and problems related to objects and events in the environment, and explore possible answers and solutions (e.g., create a mould of a fossil and use the mould to make a replica of the fossil to demonstrate how the fossil was formed; design and carry out an investigation using sand structures to show the relationship between volume of water and erosion)

Relating Science and Technology to the World Outside the School – conduct their investigations of the outdoor environment in a responsible way and with respect for the environment (e.g. leave the site of the investigation as they found it, putting back objects examined where they found them and taking away all equipment brought to the site).

This School is like a Day at the Beach!



*Note to Ontario Teachers: If you are fortunate to be living and teaching in an area close to one of the Great Lakes or one of the smaller “great” lakes of Ontario, this activity requires a planned Field Trip to the beach area at your local lake. It is recommended that the trip take place in the spring or fall to avoid extreme weather conditions. Sunscreen, sunglasses, and protective clothing are always necessary for safety. The purpose of the Field Trip is to study erosion and fossils and learn ways to be environmentally respectful at the waterfront.

Materials Needed For Activity:

Teacher:

- Permission Forms / Adult Chaperones / Transportation / Attendance List / Agenda / Activity Sheets
- Plastic pails with volume measurement marks inside
- Trowels / small hand shovels
- Stop watches
- Cafeteria lunch trays
- Yard rakes (for students to rake sand back to original condition)

Students:

- Sunscreen, sunglasses, long-sleeves, pant legs, and outdoor running shoes
 - Backpack / School bag
 - Litter-less Lunch
 - Clipboard and pencils
- 1) Divide students into groups of 4 and assign one pail, trowel/shovel, stop watch and tray per group
 - 2) Distribute Handout #2 to each student to attach to clipboards and complete on beach
 - 3) Before exiting the bus explain to students the expectation to “leave the site of the investigation as they found it, putting back objects examined where they found them and taking away all equipment brought to the site”. Ask why this is important environmentally (preservation / conservation / pollution & litter reduction / ecological safety) and also why this is crucial to helping prevent erosion (not removing or disturbing sand, soil, vegetation, rocks, etc.)
 - 4) End of day: use attendance sheet to account for students, equipment return, and completed worksheets

PLEASE READ YOUR INSTRUCTIONS CAREFULLY. YOU ARE RESPONSIBLE FOR WORKING TOGETHER AS A GROUP TO COMPLETE THIS DOUBLE-SIDED WORKSHEET.



PART 1: EROSION

- 1) Notice the beach environment around you. Are there any structures, areas of vegetation, or rocky areas which are helping prevent erosion of the shoreline? Describe them and how they help.

- 2) Build a sandcastle! Using only the equipment given to you, build a sandcastle that meets the following requirements:
 - the sandcastle must be constructed on TOP of the tray
 - the tray must be tilted UP on one end, approximately 5-10cm, using rocks found
 - the amount of sand you use in construction must be measured and recorded below (use the measurements inside the pail to add up ALL of your construction “material”)
- 3) Once your castle is built, please continue the activity:
 - use the same pail to collect water from the lake and record the amount of water below
 - assign one task to each group member:
 - one person will help support tilted tray;
 - one person will use stopwatch to time the complete erosion of your sandcastle;
 - one person will observe the erosion process and advise the timer when to start and begin timing;
 - final group member will pour the water slowly and steadily from the bucket to the top of the tray, just in front of the base of your sandcastle

Sandcastle Specifications

Volume of Sand in Sandcastle (Show unit of measurement)	Volume of Water collected from lake (Show unit of measurement)	Amount of Time *use stopwatch to time how fast castle erodes when water is poured slowly but steadily onto base of sandcastle (Show unit of measurement)	Erosion! Describe the process of erosion:
_____	_____	_____	_____ _____ _____ _____

**Soil or sand erosion is the movement of soil or sand from one place to another. The two main forces causing erosion are wind and flowing water.
Imagine pouring all of the lake’s water on your sandcastle! Erosion is a powerful force!**

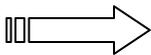
PART II: FOSSILS



Fossils can be found anywhere you would find _____
(sedimentary / scientific) rocks.

Fossils of sea creatures are often found because their bodies cannot completely
_____ (dive / decay) underwater.

This lake is probably a good place to locate fossils because of the availability of
_____ (rocks / fish) washed up on shore that are _____ (small /
large) in size and easily examined.



As a group, go on a Fossil Finding Mission in the area outlined by
your teacher! **DO NOT GO INTO THE WATER!**

- Hints: *Fossils are commonly found in the crevices around large rock piles, or
freshly washed up on the shore
- *Try to not disturb the natural environment: do not uproot vegetation,
destroy natural habitat, injure wildlife, or vandalize/damage the area
 - *Once you have found your first fossil, sit down **IMMEDIATELY** as a
group in the exact location of discovery. This will help you return the
fossil to its original location. Why is it important to return anything
that humans find to its original condition in the environment? Discuss.
 - *Once you are seated, begin the quiz below!

Group Memory Quiz:



- 1) Our fossil is a _____ (Trace / Imprint / Solid) fossil.
- 2) Our fossil is likely a _____ (plant / animal) fossil.
- 3) P _____ (Podiatrists / Paleontologists) study fossils.
- 4) Fossils are _____ (hundreds/thousands/millions) of years old.
- 5) Name one thing your group can do to restore this beach area to
the condition you found it in:

Once your teacher or chaperone has checked your answers, please
proceed with your group clean-up idea!