Anglophone School District - North

Grade 7 Science - Unit Lesson Guide

Earth's Crust

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The Aim of Science Education - Scientific Literacy

The aim of science education in the Atlantic Provinces is to develop scientific literacy.

Scientific Literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

The Three Processes of Scientific Literacy

An individual can be considered Scientifically Literate when he/she is familiar with, and able to engage in, three processes: Inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanation for phenomena. While there is a general agreement that there is no such sing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important to their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Science Assessment Overview

Science is a hybrid term that houses different disciplines such as: Physics, Chemistry, Biology, Environmental Studies, Engineering, Math, etc. Given this broad spectrum, it is not realistic that we can paint science assessment with a single brush in terms of probes that work for every science activity. However, regardless of school subject, let alone science, the frequency of assessment should be unbalanced with formative assessment occupying 80% of practise and summative with the remaining 20%.

80% Formative - 20% Summative

Formative Assessment
Formative assessment is a range of formal and informal assessment procedures employed by teachers during their learning process in order to modify teaching and learning activities to improve student attainment. It typically involves qualitative feedback (rather than scores) for both students and teacher that focuses on the detail of content and performance. Feedback is the central function of formative assessment. It typically involves a focus on the detailed content of what is being learnt.

Science Formative Assessment falls into 2 distinct categories, and they are divided about how feedback is given. Please be aware that an activity could be informal or formal, it is the purpose of the task that determines purpose.

Informal Formative
Informal Formative Science Assessment acts as a monitoring probe and is distinct because it is not graded.

Formal Formative
Formal Formative Science Assessment provides specific feedback to students, the teachers corresponds via anecdotal feedback, rubrics, and written responses to offer progress to student attainment.

Summative Assessment
Summative assessment seeks to monitor educational outcomes, often for the purposes of external accountability. Usually occurring at the end of a learning unit and determines if the content being taught was retained.

Earth's Crust

Focus and Context

An inquiry-based approach to this unit will permit the students to investigate many of the properties of the Earth to which they have had some exposure. The most recent and widely accepted theory that is used to explain many crustal features and phenomena, continental drift, is formally introduced and should be approached using crustal phenomena that are both relevant and motivating to the students. The context for this unit can be the rocks, minerals, and evidence of geological processes in the local environment of the student.

Unit Instructional Overview

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* - EECD Grade 7 Inquiry package - available at https://portal.nbed.nb.ca/tr/lr/k-8Science/Pages/default.aspx

Earth's Crust - Curriculum Outcomes

Geological Plate Tectonics and Time Scale	311-4 compare some of the catastrophic events, such as earthquakes and volcanic eruptions, that occur on or near Earth's surface	209-4, 210-6, 311-5 organize and analyze data on the geographical and chronological distribution of earth quakes and volcanoes to determine patterns and trends	110-4 describe how plate tectonic theory has evolved in light of new geological evidence
	110-1 provide examples of ideas and theories used in the past to explain volcanic activity, earthquakes, and mountain building	112-12 provide examples of Canadians and Canadian institutions that have contributed to our understanding of local, regional, and global geology	
	311-1 explain the processes of mountain formation and the folding and faulting of the Earth's surface	209-4, 311-6 develop a chronological model of geological time scale of major events in Earth's history	
Rocks and Minerals	210-1classify minerals on the basis of their physical characteristics by using a dichotomous key	211-3 work co-operatively with team members to plan how to determine a geological profile of a land mass by using simulated core sampling techniques	
	210-12, 211-4 evaluate the individual and group processes in planning how to determine a geological profile of a land mass using simulated core sampling in geological models	109-7, 111-2, 310-1 describe the composition of Earth's crust and some of the technologies which have allowed scientists to study geological features in and on the earth's crust	
The Rock Cycle	208-2 identify questions to investigate arising from the study of the rock cycle	209-6 use tools and apparatus safely when modeling or simulating the formation of rock types	
	310-2b classify rocks on the basis their characteristics and method of formation: sedimentary, igneous, metamorphic	112-3 explain how society's needs led to developments in technologies designed to use rocks	
Weathering	311-2 explain various ways in which rocks can be weathered: mechanical Chemical		
Soil	209-1 design and conduct a fair test of soil properties	310-3 classify various types of soil according to their characteristics, and investigate ways to enrich soils	
	311-3 relate various meteorological, geological, chemical, and biological processes to the formation of soils	113-1 identify some positive and negative effects and intended and unintended consequences of enriching soils	
	112-7 provide examples of how science and technology associated with soil enrichment affects their lives	113-7 suggest solutions to problems or issues related to soil use and misuse	

Earth's Crust

Strand - Geological Plate Tectonics and Time Scale

General Curriculum Outcomes	Specific Curriculum Outcomes
311-4 examine some of the catastrophic events, such as earthquakes or volcanic eruptions, that occur on or near Earth's surface	311-4 compare some of the catastrophic events, such as earthquakes and volcanic eruptions, that occur on or near Earth's surface
209-4 organize data, using a format that is appropriate to the task or experiment	209-4, 210-6, 311-5 organize and analyze data on the geographical and chronological distribution of earth quakes and volcanoes to determine patterns and trends
210-6 interpret patterns and trends in data, and infer and explain relationships among the variables	
311-5 analyse data on the geographical and chronological distribution of catastrophic events to determine patterns and trends	
110-4 describe examples of how scientific knowledge has evolved in light of new evidence	110-4 describe how plate tectonics theory has evolved in light of new geological evidence
110-1 provide examples of ideas and theories used in the past to explain natural phenomena	110-1 provide examples of ideas and theories used in the past to explain volcanic activity, earthquakes, and mountain building
112-12 provide examples of Canadians contributions to science and technology	112-12 provide examples of Canadians and Canadian institutions that have contributed to our understanding of local, regional, and global geology
311-1 explain the process of mountain formation and the folding and faulting of Earth's surface	311-1 explain the processes of mountain formation and the folding and faulting of the Earth's surface
209-4 organize data, using a format that is appropriate to the task or experiment	209-4, 311-6 develop a chronological model or geological time scale of major events in Earth's history
311-6 develop a chronological model or time scale of major events in Earth's history	

Science Resource Package: Grade 7

Earth's Crust:
Plate Tectonics

New Brunswick Department of Education

September 2009

ⓘ Background Information

Prior Knowledge:

Students have:

Some knowledge of rocks, minerals, soils, and the rock cycle from grade 4

Common Misconceptions:

“There are no earthquakes, volcanoes, or fault lines in Canada.”

“Volcanoes aren’t erupting anymore, only in the past.”

“Earthquake damage occurs when the Earth cracks open and swallows things. Shaking doesn’t cause much damage.”

“Earth is solid and attached all the way through.”

Did You Know?

The Earth’s crust is not a static and unchanging entity. Continents have moved relative to one another. The present theory of plate tectonics is supported by geological evidence (similar rock layers now separated by oceans), biological evidence (fossil evidence of the same species now separated by oceans), and meteorological evidence (e.g. coal deposits in Antarctica that need to form in warm climate). The pattern of the age and magnetic reversals in the ocean floor also support this theory.

Most geologists agree that convection currents are responsible for the movement of the tectonic plates. There is much about this mechanism of movement that is still unknown. This is an area where scientific knowledge is expanding and changing, as new ways of collecting information are discovered.

Vocabulary:

This vocabulary is not necessary for the students to know but appears in a wide number of resources including the Science Power 7 Textbook.

Convergent boundary –an area on Earth’s crust where two plates are pushing against each other; this can result in mountain building if two continental plates or subduction if one continental and one oceanic plate

Subduction zone - a place on the Earth’s crust where one tectonic plate is moving under another; earthquakes often occur in subduction zones

Divergent Boundary –an area of Earth’s crust where two plates are moving apart from each other; most active divergent plate boundaries are between oceanic plates and tend to have volcanic activity

Instructional Plan

Prior to unit

Have students collect current data on earthquake and volcanic activity, record it in a table and plot it on a world map on the wall, on a globe, or on Google Earth.

Daily bulletins of earthquake activity are available free of charge from: http://earthquake.usgs.gov/eqcenter/recenteqsww/Quakes/quakes_all.php The earthquake locations are given with latitude and longitude coordinates. The strength of the earthquake is also given so you may develop a colour code (of sticky dots or push pins) for strength. Note that earthquakes below 4.0 are given for only North America.

Bulletins of volcanic activity are available from http://www.volcano.si.edu/reports/usgs/.

This photo has earthquake data from May 29 to June 25, 2009.
Legend: blue 2 to 2.9, green 3 to 3.9, yellow 4 to 4.9, red ≥ 5.

A month's worth of data gives an indication of the plates. After a month, only larger earthquakes need to be plotted (magnitude 4 and up) to add further detail.

The purpose is to have students use authentic data to gradually define the boundaries of the tectonic plates. Note that students are not told to be looking for a pattern yet.

SCIENCEPOWER 7 (p.331) has a list of historical data that could be used to get students started or this data could be added to the map just as the unit is begun.

Access Prior Knowledge

✪ Curriculum Outcomes

311-4 Compare some of the catastrophic events, such as earthquakes and volcanic eruptions, that occur on or near the Earth's surface.

Activity

- In small groups, have students brainstorm "What do you know (and wonder) about earthquakes and volcanoes and their causes?" You may have students print ideas on large papers for ease of sharing and posting on the bulletin board.
- Ideas are then shared with the whole class and recorded in a large KWL chart on the bulletin board. (The "L" column will be used later)

know	wonder	learned

- What would it be like to be in an earthquake? Look like? Sound like? Feel like?

  Videos Dragonfly TV at http://pbskids.org/dragonflytv/show/earthquakes.html may be helpful

  This video shows some of what happened in the San Francisco earthquake http://videos.howstuffworks.com/hsw/9216-investigating-earthquakes-earths-moving-crust-video.htm

  Panic in the Ring of Fire sections: People's homes after the earthquake, The hospital after the earthquake, A survivor of the 2004 eruption of Mount Merapi, Surviving from a direct path of lava flow (be sure to preview this first as there are some disturbing pictures) http://learning.aliant.net/Player/ALC_Player.asp?ProgID=DISC_PANIC

- Have students create a journal entry comparing conditions after an earthquake and volcanic eruption.

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

When reading the journal entries, note which students are able to compare conditions after an earthquake or volcanic eruption.

✓ **Assessment:**

Note the concepts and misconceptions students are expressing. You will need to know these to plan effective questions for subsequent activities and discussions so that students will examine and adjust their alternate conceptions.

Post student versions of curricular outcomes on chart paper (see page 20). Inform students that these outcomes will be addressed over the next portion of the unit. Point out to students which outcomes are being addressed in each activity.

🚲 1st Cycle

✪ Curriculum Outcomes

209-4 Organize data, using a format that is appropriate to the task.
210-6 Interpret patterns and trends in data, and infer and explain relationships.
311-4 Compare some of the catastrophic events, such as earthquakes and volcanic eruptions, that occur on or near the Earth's surface.
311-5 Analyse data on the geographical and chronological distribution of catastrophic events to determine patterns and trends.

Map Pattern Activity

- Either refer to map activity done prior to unit (see page 4).

  Or, if the students did not start this yet, have students plot the data from the table in *SCIENCEPOWER 7* (p.331) on a world map and look online for more recent data (since 1989), record it in a table and then add to map. (Organizing and recording online data could be observed to assess outcome 209-4 listed above.) Students could be divided into groups and with each group plotting a portion of the data on an overhead. These could be layered on the overhead to show the full scope of the data.

  Or, earthquakes from the past week are plotted on this Google Earth image (need to have Google Earth installed on your computer): http://www.google.com/gadgets/directory?synd=earth&cat=featured&url=http%3A%2F%2Fwww.google.com%2Fmapfiles%2Fmapplets%2Fearthgallery%2FReal-time_Earthquakes.xml
  If you are using this Google Earth image to show students earthquake activity, uncheck the box for showing tectonic plate boundaries as students are to look for these boundary patterns in the earthquake and volcanic activity.

  Or, earthquakes from the past week are plotted at this site: http://earthquakes.tafoni.net/

Think and share – 2, 4, 8

- With a partner, have students look for patterns on the map. What could be happening? Have students record their observations and thoughts.
- Each pair of students should join with another pair (to make a group of 4) to share their ideas and add to their lists.

- If time allows and the class is of sufficient size, have the groups of 4 join with another to make a group of 8. Again, ideas are shared and individual students may wish to add ideas to their lists.

Reflection: Class Discussion

- Have students share their observations and thoughts (conclusions). *See teacher's note about encouraging classroom talk (see pages 17-18).*

- Emphasize that scientific knowledge is based on evidence and gets revised or changed whenever contradictory evidence is confirmed. Look back at ideas in KWL chart from Accessing Prior Knowledge activity (page 5). *Do we need to revise or add to any of these? Can any items be moved to the "learned" column? Is there other information we could add?*

Reflection: Journaling

Have students journal about the observed patterns of tectonic activity.

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

When reading the journal entries, note which students are seeing a pattern and which are not sure there is a pattern.

🚲 2nd Cycle

✪ Curriculum Outcomes

110-4 Describe how plate tectonic theory has evolved in light of geological evidence.
210-12 Identify and evaluate potential applications of findings.

Continental Shapes Activity

In pairs and using the Continent Shapes sheet (page 21):

- Have students use an atlas or globe to label the continents.
- Direct students to look at the shape of continents. Ask: *What do you notice?*
- Have them cut out the continents like jigsaw puzzle pieces and explore, moving the continents around to see what they notice.

Circulate to facilitate this. "Those two kind of fit together. I wonder if they all would fit together."

Another option:

The Explore Learning site has simulations called Gizmos.

The link below is to a Gizmo called "Building Pangaea". The Gizmo allows students to drag and rotate the continents to explore how they might have fit together. It could be used instead of the paper continent pieces.
http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=633
The site allows unregistered users to run each Gizmo for 5 minutes a day. It is also possible to sign up for a free trial. Membership is not free.

Teacher note: Wegener was the first scientist to propose continental drift: that the Earth's continents had once all been joined together and that they had drifted to their current positions over a long period of time. He called the original super continent Pangaea. His ideas were not accepted because there was no known mechanism for continental movement.

A possible misconception is that students think the continents are floating on a sea of molten rock and that there are gaps between the plates. In reality, the entire Earth is covered with the Earth's crust and the tectonic plates are in contact with each other.

Reflection: Class Discussion

- Ask the class: *What did you discover/notice? What are the potential implications of the continents fitting together?*

Some possible videos to support or extend ideas at http://learning.aliant.net/ Videos are available free of charge at this site. You need to register, however registration is free. If you try to watch the video without logging in, you are prompted to do so. Note that a table of contents opens beside the video so that you may select only certain sections for viewing if you wish. There is also an option to watch the video full screen.

"Making the Pieces Fit" - section called The Idea of Continental Drift

"The Birth of a Theory"

"Volcanoes (Junior)" - up to the end of the section on Plates

http://www.scotese.com/pangeanim.htm - This site has an animation illustrating the movement of tectonic plates over various periods of time.

NSTA (National Science Teachers Association) has a free resource showing fossil, glacial, and rock type evidence supporting plate tectonic theory. To view this resource, go to:
http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/7/SCB-PT.5.1

- Emphasize that scientific knowledge is based on evidence and gets revised or changed whenever contradictory evidence is confirmed. Look back at ideas in KWL chart from Accessing Prior Knowledge activity (page 5). Ask: *Do we need to revise or add to any chart items? Can any items be moved to the "learned" column? Is there other information we could add?*

Reflection: Journaling

- Explain what you understand about the movement of continents. Explain what seems to be too fantastic to be true.

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

When reading the journal entries, note where students are in their understanding and which misconceptions they are holding on to.

✓ **Assessment:**

In temperate regions of the world, like Canada, there are coal deposits made from tropical vegetation. Using plate tectonic theory, explain how this is possible.

Possible extensions:

- Student(s) could create a foldable with different layers and using the continent cut out shapes to show different stages from Pangaea to today's configuration of the continents.
- Students could do research to summarize the types of evidence supporting plate tectonic theory.
- Research Wegener and write a biography.

Continent Shapes

🚲 3rd Cycle

✪ Curriculum Outcomes

110-4 Describe how plate tectonic theory has evolved in light of geological evidence.
209-6 Use tools and apparatus safely.
210-12 Identify and evaluate potential applications of findings.

Where the Plates Meet Activity

Materials:

- Saltine crackers
- Corn syrup or corn starch and water
- Foil brownie pan or other small pan
- Popsicle sticks or coffee stir sticks

Procedure:

1. Place enough corn syrup or cornstarch/water to cover the brownie pan to a depth of about half a centimetre.
2. Gently place a single layer of crackers on the syrup or cornstarch/water.
3. Carefully move the crackers about as they float on the syrup or cornstarch/water. See what happens when the crackers collide, spread apart, rub past each other, and slide over top one another. For each of these situations, draw which direction the plates are moving using diagrams with arrows and what is happening to the syrup. You may wish to give students the recording sheet on page 23.

The following link gives teachers some tips on doing the cracker/corn syrup activity.
mms://stream.nbed.nb.ca/video/portal/EarthsCrust.wmv

✓ Assessment:

On observation chart (or other record), note how students are performing on the skill

Reflection: Class Discussion

- Ask: *Are the Earth's plates square? What shape do you think the Earth's plates are?*

  Discussion should review the idea of the tectonic plates defined by earthquakes and volcanoes from the first cycle. Record ideas on card or large stickies to add to the KWL chart. The edges of the crackers got "messy" and in the Earth's crust the edges of the plates are "messy" with earthquakes and volcanoes.

  Some students may have noticed the corn syrup oozing up through the holes in the crackers. The same thing can happen with the Earth's crust where there is a thin or weak spot.

This can also be demonstrated with a tube of toothpaste. Take a tube of toothpaste, make a hole and then push on either end to make the "magma" squirt out of the hole. This is an excellent illustration of magma oozing through a crack or at plate boundaries.

- Refer back to the world map with the earthquakes and volcanoes marked. Predict the motion of the plates or other events happening at locations with a high concentration of earthquakes and volcanoes.

- Look back at ideas in KWL chart from accessing prior knowledge activity (page 5). Ask: *Do we need to revise or add to any of these? Can any items be moved to the "learned" column? Is there other information we could add?*

Reflection: Journaling

Why isn't it likely that we would have a major earthquake in New Brunswick? Does that mean that we never get earthquakes in NB?

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

When reading the journal entries, note which students have the idea that the majority of earthquakes occur along the tectonic plate boundaries and that New Brunswick is not very near a boundary.

Possible extensions:

Look for news articles reporting on earthquake and/or volcanic activity. “Quake stretched New Zealand toward Australia” is a good example. It is from the Science and Technology news part of CBC’s site
http://www.cbc.ca/technology/story/2009/07/22/tech-new-zealand-earthquake.html

Research how the location of an earthquake is determined.

Tsunamis are sometimes associated with earthquakes. Do research to find one or more examples of this. Why do some earthquakes cause tsunamis and others do not?

Where the Plates Meet Activity

Materials:

Saltine crackers,
Corn syrup or corn starch and water,
Foil brownie pan or other small pan

Procedure:

- Place enough corn syrup or cornstarch/water to cover the brownie pan to a depth of about half a centimetre.
- Gently place a single layer of crackers on the syrup or cornstarch/water.
- Carefully move the crackers about as they float on the syrup or cornstarch/water.
- See what happens when the crackers collide, spread apart, rub past each other, and slide over top one another.
- For each of these situations, draw which direction the plates are moving, using diagrams with arrows, and what is happening to the syrup.

Where the Plates Meet Recording Sheet

Type of movement to explore	Observation (in words)	Diagram (top view)	Diagram (side view)
1 cracker			
2 crackers pushing against each other			
3 crackers in a line, pushing toward the center cracker from the two sides			
4 or 6 crackers			

Choose one of the above situations and imagine it is happening to the Earth's crust. You are a news reporter. Write a news story reporting on this situation.

🚲 *4th Cycle*

✪ Curriculum Outcomes

110-4 Describe how plate tectonic theory has evolved in light of geological evidence.
209-6 Use tools and apparatus safely.
210-12 Identify and evaluate potential applications of findings.
311-1 Explain the processes of mountain formation and the folding and faulting of the Earth's surface.

Introduce the role plate tectonics has in mountain formation with this video clip using an egg as a model for the Earth:
http://www.youtube.com/watch?v=X9lOcm_CcBQ

This site has an interactive simulation where the direction of plate movement can be selected and the impact on the Earth's crust observed:
http://www.pbs.org/wgbh/aso/tryit/tectonics/

Mountain Formation Activity

Using layers of different coloured playdough or plasticene, students can simulate mountain building. Directions for this activity can be found at: http://www.coaleducation.org/lessons/middle/mountain_building.htm

Materials:

4 different colours of plasticene or play dough
Plastic wrap to cover 2 books

Have students:

Stack four different coloured layers of plasticene on top of one another.
Stand the books upright on opposite sides of the plasticene.
With a partner, gently push the books toward each other.
Notice what happens to the "Earth's crust".

✓ **Assessment:**

On observation chart (or other record), note how students are performing on the skill

Reflection: Class Discussion

- Ask: *What do you think are the characteristics of mountains formed in this way?*
- Look at a globe with relief or in an atlas for maps indicating mountain ranges. Ask: *Where do you think there are mountains that might have formed in this way?*

- Look at the mountains under the oceans. These can be seen using Google Earth. Ask: *Do you think these mountains have been made by tectonic plates pushing against each other? How else might they be formed?*
- Look back at ideas in KWL chart from accessing prior knowledge activity (page 5). Ask: *Do we need to revise or add to any of these? Can any items be moved to the "learned" column? Is there other information we could add?*

Reflection: Journaling

Explain mountain building using plate tectonic theory. Use diagrams to help you explain.

and/or

If new crust (rocks) are being created, why isn't the Earth getting bigger?

> ✓ **Assessment:**
> Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.
>
> When reading the journal entries, note which students discuss mountain building and/or subduction of one tectonic plate under another.

Possible extensions:

Do research to find the name and height of the highest mountain on each continent. Create a graph to show your information.

At http://learning.aliant.net/ "World in Motion" This video summarizes many of the ideas introduced throughout this part of the curriculum. Videos are available free of charge at this site. You need to register, however registration is free. If you try to watch the video without logging in, you are prompted to do so. Note that a table of contents opens beside the video so that you may select only certain sections for viewing if you wish. There is also an option to watch the video full screen.

Bill Nye's the Science Guy – Earth's Crust (3 videos) Explores the science of the Earth's crust. If the earth was the size of a hard boiled egg, its crust would only be about the thickness of the shell. The crust and the movements of its tectonic plates are responsible for creating mountains, volcanoes, and earthquakes.

Clip 1 http://www.youtube.com/watch?v=ni7Gwkf3PkM&feature=related

Clip 2 http://www.youtube.com/watch?v=7SKQAc_HrBs&feature=related

Clip 3 http://www.youtube.com/watch?v=GR1ORWStLAQ&feature=related

Time Scale of Major Events in Earth's History

Outcomes:
112-12 provide examples of Canadians and Canadian institutions that have contributed to our understanding of local, regional, and global geology
209-4, 311-6 develop a chronological model or geological time scale of major events in Earth's history

209-4 organize data, using a format that is appropriate to the task or experiment
311-6 develop a chronological model or time scale of major events in Earth's history

Lesson Activity Overview
Students should begin to appreciate the magnitude of time involved in most geological processes and events. Students can prepare and construct their own life time scale and compare it to a geological time scale.
Students should come to realize that geological time has been subdivided into eras, periods, and further into epochs.
Features that may be included in a geological time scale are such things as fossils and periods of mountain building. It is not intended that students memorize the names of these subdivisions or their order.

<u>Task</u>
Produce a chronological time scale of some major events in human history and compare it to Earth's history. (209-4, 311-6)

During the creation of a geological time scale, students should have the opportunity to learn about Canadian geologists such as Tuzo Wilson and Joseph Tyrrell, as well as Canadian institutions involved with geological research such as the Geological Survey of Canada. It is the work and research of these people and institutions, as well as many others, that is the basis of our current understanding of the earth and its geological history.

<u>Journal</u>
Who is Tuzo Wilson and what were his contributions to the theory of plate tectonics?

Assessment:Informal Formative
Ensure that students have participated in discussion about Canadian Contributions to Plate Tectonics 112-12

Assessment:Formal Formative
Ensure that students have created a journal entry about Tuzo Wilson or another Canadian Scientist who has contributed to plate tectonic research 112-12

Ensure that students have created a chronological time scale of major human events that compares to Earth's History 209-4, 311-6

Understanding Ancient Cultural Beliefs

Outcomes:
110-1 provide examples of ideas and theories used in the past to explain volcanic activity, earthquake, and mountain building
211-4 Evaluate group processes used in completing a task

Lesson Activity Overview
Different cultures throughout history have had ideas and theories about the origins and causes of volcanic and earthquake activity and mountain formation. Students can be challenged to investigate a particular group or culture in order to learn about peoples' ideas about these events in the past.

Some possible research ideas might include:
- Pele (Hawaiian goddess who makes the mountains shake and lava flow at Kilauea, Hawaii)
- Glooscap (Mi'kmaq legend about the Sugarloaf Mountains)
- Ovid (Roman poet who claimed that earthquakes occurred when the earth became too close to the sun and trembled from the great heat)
- Anaxagoras (Greek who believed that volanic eruptions were caused by great winds within the earth)
- René Descartes (French philosopher who believed incandescent earth core was the source of volcanic heat)

<u>Tasks:</u>
Students could work in groups to combine the research topics (above) to the type of project that they would like to do.

Investigate how people in the past explained catastrophic events such as volcanoes and earthquakes. (110-1)

Prepare a mural of ancient stories that are associated with volcano and mountain building. (110-1)

Prepare a recording or short dramatization that illustrates how a certain culture explained volcanic or earthquake activity. (110-1)

Assessment:Informal Formative
Ensure that students work cooperatively in groups and evaluate the roles in completing a group task 211-4

Assessment:Formal Formative
Ensure that students have appropriately completed one of the tasks based on establish criteria 110-1

Earth's Crust

Strand - Rocks and Minerals

General Curriculum Outcomes	Specific Curriculum Outcomes
210-1 use or construct a classification key	210-1, 310-2a classify minerals on the basis of their physical characteristics by using a dichotomous key
310-2a classify minerals based on their physical characteristics by using a dichotomous key	
211-3 work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise	211-3 work cooperatively with team members to plan how to determine a geological profile of a land mass by using simulated core sampling techniques
210-12 identify and evaluate potential applications of findings	210-12, 211-4 evaluate the individual group processes in planning how to determine a geological profile of a land mass using simulated core sampling in geological models
211-4 evaluate individual and group processes using a planning, problem solving, decision making, and completing a task	
109-7 identify different approaches taken to answer questions, solve problems, and make decision	109-7, 111-2, 310-1 describe the composition of Earth's crust and some of the technologies which have allowed scientists to study geological features in and on the Earth's crust
111-2 provide examples of technologies used in scientific research	
310-1 describe the composition of Earth's crust	

Mineral Classification

Outcomes:
210-1, 310-2a classify minerals on the basis of their physical characteristics by using a dichotomous key

210-1 use or construct a classification key
310-2a classify minerals based on their physical characteristics by using a dichotomous key

Lesson Activity Overview
The purpose of this lesson is for students to identify minerals based on a physical characteristics. Students should test for streak, colour, lustre, and hardness. From these tests students will use a dichotomous key to identify the mineral in question. Why use a dichotomous key? Students identify a few, carefully selected rock/minerals. During the tests, the checks are built in to correct errors and to be time efficient. Students can progress at their own pace, in any order they choose.

1. As a class, acting as a model, one mineral is chosen. The teacher leads the model and performs tests based on the cues in the dichotomous key. Everyone works together to identify the mineral.
2. Next, students work with lab groups to continue identifying the remaining minerals samples. (teachers should assign several different minerals to each group before the lab starts)

<u>Mineral Samples</u>: Calcite, Chalcopyrite, Copper, Corundum, Galena, Graphite, Halite, Magnetite, Pyrite, Quartz, Sulfur, Talc

<u>Identification Tools</u>: White streak plate, Glass, Magnet, dilute hydrochloric acid, eyes.

Instructions:
Your teacher will instruct your group to begin with igneous, metamorphic, or sedimentary rocks.

1.Obtain the materials listed above.
2.Starting with the first mineral in your kit, determine if it is metallic or nonmetallic. (Remember, a mineral must look like a metal if it is metallic.)
3.Continue through the dichotomous key until you determine the name of the first mineral sample.
4.Write the name of the mineral in your data table. If you are unable to correctly identify the mineral, skip it and move onto the next mineral sample.
5.Complete steps 2-4 to identify the names of the remaining mineral samples.
6.Check your answers with the teacher. Re-do any minerals that were incorrectly identified.

Name of Mineral	Number	Name of Mineral	Number
Calcite		Halite	
Chalcopyrite		Magnetite	
Copper		Pyrite	
Corundum		Quartz	
Galena		Sulfur	
Graphite		Talc	

<u>Journal:</u>
Why was calcite difficult to distinguish from halite?

Given several pairs of minerals that look similar, write a note to another student describing several tests that may help differentiate them.

Assessment:Informal Formative
Ensure that students use dichotomous keys to identify minerals 210-1

Assessment:Formal Formative
Ensure that students have correctly completed the data table for mineral identification. 310-2a

Ensure that students have completed journal entry, why was calcite difficult to distinguish from halite? 310-2a

Ensure that students have completed a journal entry, Given several pairs of minerals that look similar, write a note to another student describing several tests that may help differentiate them. 210-1

Identification of Minerals - Dichotomous Key

Does the mineral have metallic luster?	Yes	Does the mineral have a gray or silver streak?	Yes	Is the mineral harder than glass?	Yes	Does mineral attract a magnet?	Yes	**Magnetite**
							No	*Go back to the beginning and start again!*
					No	Does the mineral have cubic cleavage?	Yes	**Galena**
							No	**Graphite**
			No	Is the mineral harder than glass?	Yes			**Pyrite**
					No	Is the mineral goldish green?	Yes	**Chalcopyrite**
							No	**Copper**
	No	Is the mineral white or clear?	Yes	Does the mineral show cleavage?	Yes	Does the mineral react with acid?	Yes	**Calcite**
							No	**Halite**
					No	Does the mineral scratch glass?	Yes	**Quartz**
							No	**Talc**
			No	Does the mineral scratch glass?	Yes			**Corundum**
					No	Is the mineral yellow?	Yes	**Sulfur**
							No	*Go back to the beginning and start again!*

Simulated Core Sampling

Outcomes:
211-3 work co-operatively with team members to plan how to determine a geological profile of a land mass by using simulated core sampling techniques

210-12, 211-4 evaluate the individuals and group processes in planning how to determine a geological profile of a land mass using simulated core sampling in geological models

210-12 identify and evaluate potential applications of findings
211-4 evaluate individual and group processes used in planning, problem solving, decision making, and completing a task

Lesson Activity Overview
This lesson should focus on simulating what core sampling. If possible, invite a mining company or geological surveyor into the class to explain this process and possibly show samples.
Simulations can come from internet simulations or video, if these are not used then students can construct fictitious two-dimensional or three-dimensional geological profiles, using layers of various coloured modeling clay. Students should work in groups and keep investigations to specific types of rocks and minerals native to the local area, mining activity in the province, technology used in geological surveys.

<u>Task</u>
Working in Cooperative groups, plan how to determine a geological profile of a local land mass. From the results, produce a graph to show the composition and thickness of layers in a model core sample

Assessment:Formal Formative
Ensure that students have completed a group evaluation of the group processes used in planning how to determine a geological profile of a land mass. (210-12), (211-3), (211-4)

Ensure that students have produced a graph to show the composition and thickness of layers in a model core sample. (210-12, 211-4)

Understanding Layers of Earth's Core

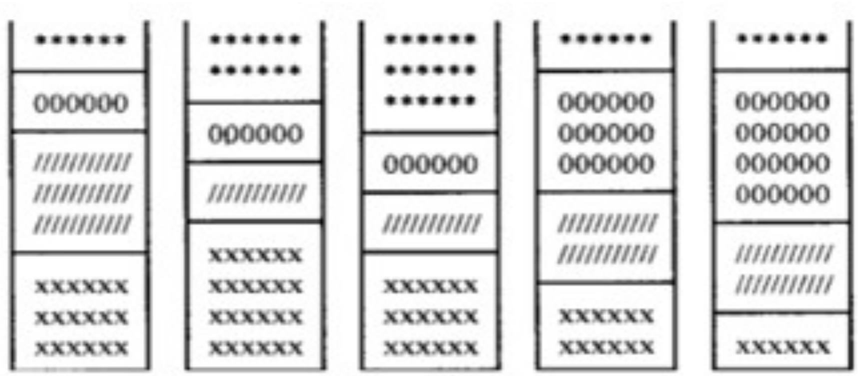
Outcomes:
109-7, 111-2, 310-1 describe the composition of Earth's curst and some of the techniques which have allowed scientists to study geological features in and on the earth's crust

109-7 identify different approaches taken to answer questions, solve problems, and make decisions
111-2 provide examples of technologies used in scientific research
310-1 describe the composition of Earth's Crust

Lesson Activity Overview

Students should learn that Earth's crust is composed of a variety of rocks and minerals in a multitude of combinations and forms. They should have exposure to the ways in which geologists investigate and explore Earth's crust by looking at some of the technologies used in gathering the data about Earth's crust. Students can investigate technologies such as satellite imaging, seismographs, remote sensing, magnometers, and core sampling.
If possible, actual core samples from a mining company or university geology department can be examined and discussed. A well-drilling contractor can be invited to class to talk about drilling through different soil and rock layers when looking for water.

<u>Task:</u>
You are given these pictorial representations of five core samples that were taken at equal intervals over a 100-metre distance (straight line). Draw the geological profile of the earth's crust for that 100-metre distance. (310-1)



Extension:
Research and write a report on a technology used to study geological features and resources. (109-7, 111-2, 310-1)

Assessment:Informal Formative
Ensure that students have been provided various examples of technologies used in Earth Core sampling 111-2

Ensure that students have been exposed to more than one approach to solving probelems reatled to the Earth Crust 109-7

Assessment:Formal Formative
Ensure that students can describe the composition of Earth Crust 310-1

Developing a Model of the Earth's Inner Structure

Outcomes:
310-1 describe the composition of Earth's crust
211-3 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise
211-5 Defend a given position on an issue or problem on the basis of their findings
205-10 Construct and use devices for a specific purpose

Materials:
• A variety of fruit and vegetables (peach, nectarine, avocado, potato, orange , apple, grape tomato)
• Paper
•Drawing Compasses
•Calculators
•Clay (Red, Green, Blue)
•Balances

Inquiry Lesson:
1. Begin with a simple question:
    - What do you know about the inner structure of the Earth?
    - What is the Earth like on the inside?

   Encourage a wide variety of responses. Offer student groups a variety of types of fruits and vegetables (peach or nectarine, avocado, potato, orange, apple, grape, tomato, etc.) and ask them to choose the one that they think best represents the structure of the Earth, especially considering what the planet is like on the inside. Be sure that they know they will be responsible for explaining their reasoning. Provide students with enough time to complete the task.

2. Ask each student group to present its fruit or vegetable choice and rationale. Because their explanations will be based on very limited knowledge, ask what they need to know about the Earth to really pick the best piece of produce as an Earth model. List their responses on the board. They should want to know more about what the inside of the Earth is like.
   During and after students' fruit/vegetable model presentations, explain the basics about the internal composition of the planet Earth. Include the basic cross section of core, mantle, and crust.

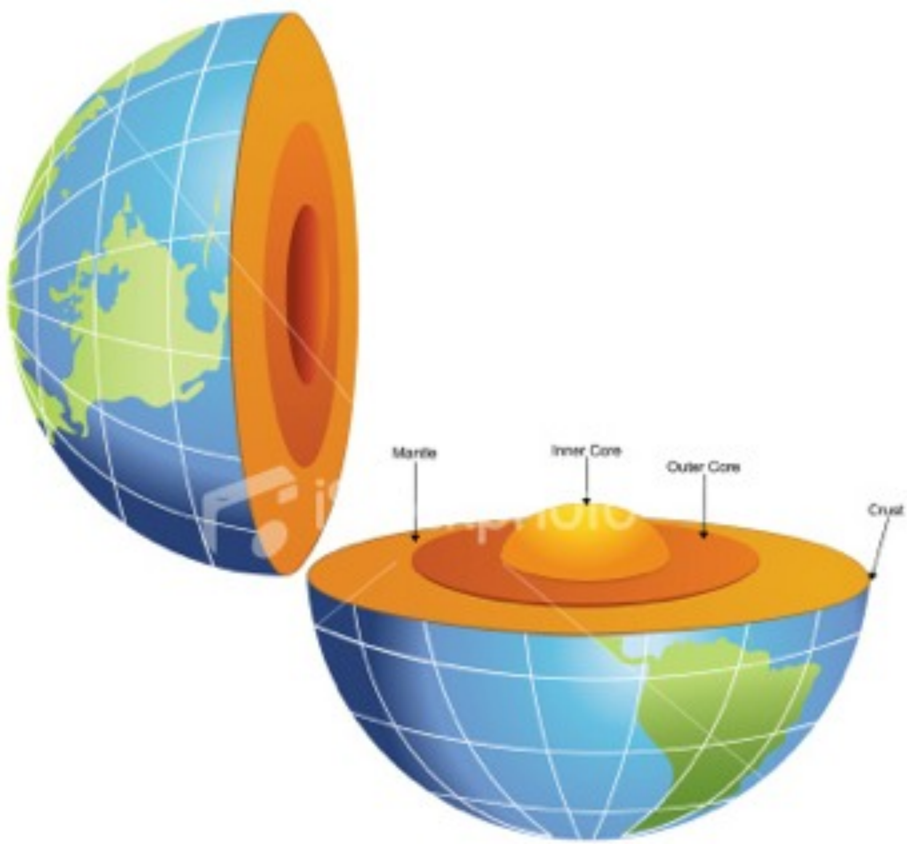
3. Ask again which produce item is the best model of the Earth, based on the students; new understanding of the facts. Ask groups to explain their answers in light of the information about the Earth's inner structure. Did they choose a different produce item this time? Why or why not?
   Have each student draw a cross section of the Earth, labeling the core, mantle, and crust. Point out that this cross-sectional model is done in two dimensions (height and

width). Also, explain that students should base their drawings on the approximate thicknesses of each layer, which are as follow:

- Core = 3400 km
- Mantle = 2900 km
- Crust = 50 km

4. Ask students,
   - If you were going to make a flat, cross-sectional model of the Earth with a diameter of 10 cm, made from three different colors of clay (core = clue, mantle = red, crust = green), how much of the each color would you need?
   - That is, would you need more blue, red. or green, and can you decide just how much you would need to make your “model Earth” in cross section?”

   For more advanced students, the answers can be found using the thickness of the Earth’s layers to calculate the proportions of clay, in grams, needed for the model. (They’ll need to consider the relative proportions of the three layers, based on the layers’s diameters, and then use those proportions to determine the relative amounts of clay, in grams, needed for the model.) If you want to add an extra challenge, ask students to make a hemispheric (i.e., three-dimensional, as opposed to the two-dimensional cross section) model with an overall diameter of 10 cm. (Encourage divergent solutions to the problem, which should involve not only the relative proportions of the three layers, but also a determination of the mass of a 10 cm clay sphere, which must then be partitioned into the three colors.) Younger students can simply estimate the approximate proportions of the three layers. Be sure that each group can explain its rationale.



5. As the student groups complete their calculations and/or estimates, offer clay and balances so they can weigh out the proper amount of each color and build their models. Groups can then compare and analyze their models for accuracy. Finally, ask students to determine and explain which is a better model of the Earth’s structure: The clay cross section or the piece of produce? Consider the sort of information each model offers, which model is most like the

actual Earth, whether the model is practical (too small, too large, etc.), and any other considerations that come to mind.

Extension:

1.Encourage students to find out more about the interior of the Earth through research, either in the library or via the internet. They can discover answers to their own questions.

2.Have students make models of other planets (based on their research of size and interior structure) and compare them to their Earth models.

Discussion Questions:

1.Which fruit or vegetable was most like the Earth? Which was least like the Earth? How do you know? Can you think of another fruit or vegetable that would make a better model of the Earth? Explain your answer.

1. How ddi your group determine the amount of each color of clay needed for your three-dimensional model of the Earth?

2. How is your clay model like the Earth? How is it different?

3. What makes something a good model of something else? What are some things to consider when making a model of something?

Assessment:

1. Were students able to choose a good fruit or vegetable model of the Earth and explain their reasoning? (Use observations made during Procedure 3 as a performance assessment, and use Discussion Question 1 as embedded evidence or as a written prompt for a science journal entry.)

2. Where students able to construct accurate clay models of the Earth, calculating or estimating the amount of clay needed for each layer? (use observations made during Procedure 4 as a performance assessment, and use Discussion Question 2 as embedded evidence or as a written prompt for a science journal entry.)

3. Could students compare and analyze the different Earth models, explaining what makes the difference between a good and a bad model? (Use Discussion Questions 3 and 4 as embedded assessments or as writing prompts for science journal entries.)

Rubric:

	Developing 1	Proficient 2	Exemplary 3
Were students able to choose a good fruit or vegetable model of the Earth and explain their reasoning?	Unsuccessfully attempted to choose a good model	Chose a good model and gave a basic explanation of how they made that choice	Chose a good model and gave a detailed explanation, including the use of appropriate terminology
Were students able to construct accurate clay models of the Earth, calculating or estimating the amount of clay needed for each layer?	Unsuccessfully attempted to construct a clay model	Successfully constructed a model and were able to calculate or estimate an accurate amount of clay for each layer	Successfully constructed a model, were able to calculate or estimate an accurate amount of clay of each layer, and were able to explain the process in detail
Could students compare and analyze the different Earth models, explaining what makes the difference between a good and a bad model?	Attempted to compare the models but were not successful to amy significant extent	Successfully compared the models and explained the basic difference between good and bad models	Successfully compared the models and explained the difference between good and bad models in detail, using appropriate terminology and offering several examples

Earth's Crust

Strand - The Rock Cycle

General Curriculum Outcomes	Specific Curriculum Outcomes
208-2 identify questions to investigate arising from practical problems and issues	208-2 identify questions to investigate arising from the study of the rock cycle
209-6 use tools and apparatus safely	209-6 use tools and apparatus safely when modeling or simulating the formation of rock types
310-2b classify and describe rocks on the basis of their method of transformation in the rock cycle	310-2b classify rocks on the basis of their characteristics and method of formation: sedimentary igneous metamorphic
112-3 explain how society's needs can lead to developments in science and technology	112-3 explain how society's needs led to developments in technologies designed to use rocks

Rock Classification

Outcomes:
208-2 identify questions to investigate arising from the study of the rock cycle
209-6 use tools and apparatus safely when modeling or simulating the formation of rock types
310-2b classify rocks on the basis of their characteristics and method of formation:
-sedimentary
-igneous
-metamorphic

Lesson Activity Overview
Students are going to learn about and classify the three different types of rocks. In keeping with Inquiry, do not give students all the information related to the rock cycle. Rather, have discussions to gauge student understanding of the different types of rocks. Based on those conversations, students should be encouraged to create questions related to differences in rocks

<u>Journal</u>
What are questions I could ask in order to investigate differences in rocks? 208-2

Next, students should complete an investigation.
Materials needed:
Igneous Rock Samples: Basalt, Gabbro, Granite, Obsidian, Pumice, Rhyolite, Scoria

Metamorphic Rock Samples: Gneiss, Marble, Mica Schist, Quartzite, Slate

Sedimentary Rock Samples: Breccia, Coal, Conglomerate, Coquina, Limestone, Sandstone, Shale

Identification Tools: Plastic container, water, eyes, magnifying lens

The teacher will instruct groups to begin with igneous, metamorphic, or sedimentary rocks.

<u>Igneous Rock Identification</u>
1.Starting with the first rock in your kit, determine if the rock is single- or multi-colored.
2.Continue through the dichotomous key until you determine the name of the first igneous rock sample.
3.Write the name of the rock in your data table. If you are unable to correctly identify the rock, skip it and move onto the next rock sample.
4.Complete steps 1-3 to identify the names of the remaining igneous rock samples.
5.Check your answers with the teacher. Re-do any rocks that were incorrectly identified.

Metamorphic Rock Identification

1.Starting with the first rock in your kit, determine if the rock has visible bands
2.Continue through the dichotomous key until you determine the name of the first metamorphic rock sample.
3.Write the name of the rock in your data table. If you are unable to correctly identify the rock, skip it and move onto the next rock sample.
4.Complete steps 1-3 to identify the names of the remaining metamorphic rock samples.
5.Check your answers with the teacher. Re-do any rocks that were incorrectly identified.

Sedimentary Rock Identification

1.Starting with the first rock in your kit, determine if the rock is composed of pebble-sized sediments.
2.Continue through the dichotomous key until you determine the name of the first sedimentary rock sample.
3.Write the name of the rock in your data table. If you are unable to correctly identify the rock, skip it and move onto the next rock sample.
4.Complete steps 1-3 to identify the names of the remaining sedimentary rock samples.
5.Check your answers with the teacher. Re-do any rocks that were incorrectly identified.

Data Table:

Igneous Rocks		**Metamorphic Rocks**		**Sedimentary Rocks**	
Name	Number	Name	Number	Name	Number
Basalt		Gneiss		Breccia	
Gabbro		Marble		Coal	
Granite		Mica Schist		Conglomerate	
Obsidian		Quartzite		Coquina	
Pumice		Slate		Limestone	
Rhyolite				Sandstone	
Scoria				Shale	

Once students have completed their investigation, they should then connect the dots between these types of rocks

Assessment:Informal Formative

Ensure that students use tools and apparatus safely when modeling or simulating the formation of rock types 209-6

Assessment:Formal Formative

Ensure that students have created a journal entry, What are questions I could ask in order to investigate differences in rocks? 208-2

Ensure that students have correctly classified different types of rocks based on using a dichotomous key 310-2b

Igneous Rocks Dichotomous Key

J. Allison & D. McCallum 2009

<table>
<tr><td rowspan="11">Does the rock have minerals you can see without magnification?</td><td rowspan="3">Yes</td><td rowspan="3">Is the rock multi-colored?</td><td>Yes</td><td colspan="9">Granite</td></tr>
<tr><td rowspan="2">No</td><td rowspan="2">Is the rock a dark color?</td><td>Yes</td><td colspan="7">Gabbro</td></tr>
<tr><td>No</td><td colspan="7">Go back to the beginning and start again!</td></tr>
<tr><td rowspan="8">No</td><td rowspan="8">Does the rock have minerals you can see with magnification?</td><td rowspan="3">Yes</td><td rowspan="3">Is the rock a dark color?</td><td>Yes</td><td colspan="7">Basalt</td></tr>
<tr><td rowspan="2">No</td><td rowspan="2">Is the rock a light color?</td><td>Yes</td><td colspan="5">Rhyolite</td></tr>
<tr><td>No</td><td colspan="5">Go back to the beginning and start again!</td></tr>
<tr><td rowspan="5">No</td><td rowspan="5">Is the rock shiny like glass?</td><td>Yes</td><td colspan="7">Obsidian</td></tr>
<tr><td rowspan="4">No</td><td rowspan="4">Does the rock have air holes?</td><td rowspan="3">Yes</td><td rowspan="3">Is the rock dark in color?</td><td>Yes</td><td colspan="3">Scoria</td></tr>
<tr><td rowspan="2">No</td><td rowspan="2">Does the rock float in water?</td><td>Yes</td><td>Pumice</td></tr>
<tr><td>No</td><td>Go back to the beginning and start again!</td></tr>
<tr><td>No</td><td colspan="5">Go back to the beginning and start again!</td></tr>
</table>

Metamorphic Rocks Dichotomous Key

J. Allison & D. McCallum 2009

Does the rock have visible bands?	Yes	Is the rock black and white in color?	Yes					**Gneiss**
			No	Is the rock a dark color like mud or clay?	Yes			**Slate**
					No	Does the rock have a sparkly substance in it?	Yes	**Mica Schist**
							No	*Go back to the beginning and start again!*
	No	Is the rock a dark color?	Yes	Does the rock scratch glass?	Yes			**Quartzite**
					No			*Go back to the beginning and start again!*
			No	Does the rock react to acid?	Yes			**Marble**
					No			*Go back to the beginning and start again!*

Metamorphic Rocks Dichotomous Key

J. Allison & D. McCallum 2009

<table>
<tr><td rowspan="10">Is the rock made of pebble-sized sediment?</td><td rowspan="4">Yes</td><td rowspan="4">Does the rock contain seashells?</td><td>Yes</td><td colspan="7">Coquina</td></tr>
<tr><td rowspan="3">No</td><td rowspan="3">Does the rock have rounded pebbles?</td><td>Yes</td><td colspan="5">Conglomerate</td></tr>
<tr><td rowspan="2">No</td><td rowspan="2">Does the rock have angular pebbles?</td><td>Yes</td><td colspan="3">Breccia</td></tr>
<tr><td>No</td><td colspan="3">Go back to the beginning and start again!</td></tr>
<tr><td rowspan="6">No</td><td rowspan="6">Is the rock made of sand-sized sediments?</td><td rowspan="2">Yes</td><td rowspan="2">Is the rock a red color?</td><td>Yes</td><td colspan="5">Sandstone</td></tr>
<tr><td>No</td><td colspan="5">Go back to the beginning and start again!</td></tr>
<tr><td rowspan="4">No</td><td rowspan="4">Does the rock react with acid?</td><td>Yes</td><td colspan="5">Limestone</td></tr>
<tr><td rowspan="3">No</td><td rowspan="3">Is the rock a shiny black color?</td><td>Yes</td><td colspan="3">Coal</td></tr>
<tr><td rowspan="2">No</td><td rowspan="2">Does the rock look like mud or clay?</td><td>Yes</td><td>Shale</td></tr>
<tr><td>No</td><td>Go back to the beginning and start again!</td></tr>
</table>

Society’s Application for Rocks and Minerals

Outcomes:
112-3 explain how society’s needs led to developments in technologies designed to use rocks

Lesson Activity Overview
The purpose of this lesson is to tie in what students have learned about rocks and minerals to how we practically use them in our everyday life. Students can investigate commercial or other human uses of rocks and how that usage relates to the properties of rock. For Example, Granites, because they are very hard and stable, are used in the construction industry. Pumice, a relatively soft rock, is used as a skin cleanser.

Begin with a Brainstorm about practical applications of rocks in society

From the conversation, frame a learning exploration. Students could choose from these tasks:

Research the uses of rocks and minerals in your region. Report on their uses to the class. (112-3)

Keep a scrapbook of pictures or sketches showing how we use rocks in or as various technologies. (112-3)

Assessment:Informal Formative
Ensure that students have participated in discussions related to the application of rocks and minerals in society 112-3

Assessment:Formal Formative
Ensure that students have appropriately completed one of the activities related to society’s use for rocks and minerals based on a rubric that was developed 112-3

Earth's Crust

Strand - Weathering

General Curriculum Outcomes	Specific Curriculum Outcomes
311-2 explain various ways rocks can be weathered	311-2 explain various ways in which rocks can be weathered mechanical chemical

Understanding Weathering

Outcomes:
311-2 explain various ways in which rocks can be weathered:
-mechanical
-chemical

Lesson Activity Overview
To begin, ensure that students understand the difference between weathering and erosion. Weathering and erosion are concepts introduced in elementary grades.
Teacher Information: Weathering is the mechanical and chemical breakdown of rock. Erosion is the process that loosens and moves sediments and weathered rocks over the earth's surface. Rocks that are created by magma or lava, sedimentation, or metamorphic processes are all exposed to the forces of weathering when at or near the surface of the earth.

In mechanical weathering, rocks are simply broken into smaller fragments. The most important type of mechanical weathering is frost action or ice wedging. Students should be encouraged to think of examples where they have seen the action of ice and frost produce broken rocks. Local cliff or seashore embankments are good locations to find this type of mechanical weathering.
When the surface layers of rock bodies are removed by erosion, pressure is released, and rocks tend to expand. Large horizontal fractures may occur this way within these rocks. The movement of plants (roots) and animals (worms, rodents, ants) move rock and soil particles about.
In chemical weathering, chemical reactions that create new substances occur within rocks. Students can investigate the effect acids (acid rain) have on some rocks such as chalk. In the first stage of chemical weathering, solutions made with water are created. Salt, gypsum and limestone are all soluble, to some extent, in water. The acidic action of some organisms such as lichens that live on rocks can cause chemical weathering. Students may be able to describe rocks or headstones in their community that are being weathered in this way. Students may investigate how rocks have been or are removed and used from local quarries. Gypsum and salt deposits in local areas can provide the context for investigating how and why these rocks are mined. Students can explore how local construction materials and styles have been determined by the availability of construction materials such as quarried rock or stone.
It is important that students differentiate between the terms weathering (process of wearing structures down) and erosion (moving weathered material). Local examples of water as both a weathering and erosion agent allow students to better understand water as the most powerful of geological forces. Gravity, glaciers, vegetation, and wind can be looked at as agents of weathering and erosion.

Assessment:Formal Formative
Ensure that students can differentiate Weathering from Erosion 311-2

Ensure that students can differentiate mechanical and chemical erosion 311-2

Understanding Weathering

1. a. Identify an example of mechanical weathering in your community.

b. Explain your justification of why this is an example of mechanical weathering.

2. a. Identify an example of chemical weathering in your community.

b. Explain your justification of why this is an example of chemical weathering.

3. What is the difference between weathering and erosion? Justify your answer with an example.

Earth's Crust

Strand - Soil

General Curriculum Outcomes	Specific Curriculum Outcomes
209-1 carry out procedures controlling the major variables	209-1 design and conduct a fair test of soil properties
310-3 classify various types of soil according to their characteristics , and investigate ways to enrich soils	310-3 classify various types of soil according to their characteristics, and investigate ways to enrich soils: coarse-textured (sandy/gravel) soil medium-textured (loamy) soil find-textured (clay) soil
311-3 relate various meteorological, geological, and biological processes to the formation of soils	311-3 relate various meteorological, geological, chemical, and biological processes to the formation of soils: rain and wind glaciers and gravity plants and acidic action
113-1 identify some positive and negative effects and intended and unintended consequences of a particular science or technological development	113-1 identify some positive and negative effects and intended and unintended consequences of enriching soils
112-7 provide examples of how science and technology affects their lives and their community	112-7 provide examples of how science and technology associated with soil enrichment affects their lives
113-7 suggest solutions to problems that arise from applications of science and technology, taking into account potential advantages and disadvantages	113-7 suggest solutions to problems or issues related to soil use and misuse

Investigation of Soil Types

Outcomes:
209-1 design and conduct a fair test of soil properties
310-3 classify various types of soil according to their characteristics, and investigate ways to enrich soils:
-coarse-textured (sandy/gravel) soil
-medium-textured (loamy) soil
-fine-textured (clay) soil

Lesson Activity Overview
This section can focus on the context of agricultural practices as they related to the use and/or abuse of our soils.

Students should investigate and classify soils as to their basic types (clay, silt, sand) and relate the soil type to other factors such as the location in which it was found.

Students will design and conduct fair tests of soil porosity and permeability.
Porosity, which is the proportion of empty space in a soil or rock, is directly proportional to the permeability of the soil or rock.
Permeability is defined as a measure of the ease with which liquids and gases pass through a soil or a rock.

Students can determine, for example, how much water is required to saturate the soil and drip through a given amount of time. Using local types of soils permits students to associate the types of vegetation growing in it.

Soils differ in organic matter, parent soil material, and the amount of air and water they contain. Students should recognize that the classification of soils is generally based on the textured qualities or how they "feel." It is also important to realize that there is a wide variety of soils owing to the great possibility of percentage compositions of the soils. Students should be able to classify and describe sandy/gravel soils, loamy soils, and clay soils. Coarse-textured soils feel gritty, and students might be able to identify the small grains, using the naked eye. Clay soils feel "greasy" with very little texture, especially when wet. A loamy soil is a soil composed of sand, silt, and clay in nearly equal proportions, and it has various textures depending on the percentages of its composite parts. A farmer or soil-management technician can be invited to class to discuss ways in which soils are enriched.

Assessment:Formal Formative
Ensure that students have designed and conducted a fair test of soil properties 209-1

Ensure that students are able to classify various types of soil based on an investigation that was designed 310-3

Testable Question: How much water is required to saturate the soil and drip through a given amount of time?

Hypothesis	State a prediction and a hypothesis based on background information or an observed pattern of events

209-1	Design and conduct a fair test of soil properties
Manipulated Variable:	Design procedures to ensure a fair test
Variables to Control:	

Data	Organize data, using a format that is appropriate to the task or experiment

Conclusion	State a Conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea

Understanding Soil Formation and Profiles

Outcomes:
311-3 related various meteorological, geological, chemical, and biological processes to the formation of soil:
-rain and wind
-glaciers and gravity
-plants and acidic action

Lesson Activity Overview
Weathering and erosion are important processes in the formation and development of soils. Students should come to understand that weathered and eroded rocks form the parent materials of soil. Organic materials provides the nutrient base for a variety of soil ecosystems.

Task
Create a scenario in which students can match and be able to explain the process below:(311-3)

Rain and wind	a. chemical
Glaciers and gravity	b. meteorological
Plants and acidic action	c. geological

Students should also investigate local soil profiles in order to appreciate the fact that soil is not of one type and a transition form parent material to nearly pure humus exists. Students should be able to locate the position of soil composition and the parent material component

This website offers a good overview of soil profiles and explains the layers of soil
http://www.cleanair.pima.gov/soil.html

Assessment:Informal Formative
Ensure that students are able to identify the layers of soil profiles 311-3

Assessment:Formal Formative
Ensure that students are able to identify the type of weathering and erosion and match and explain a scenario that represents it. 311-3

Factors Associated with Enriching Soils

Outcomes:
113-1 identify some positive and negative effects and intended and unintended consequences of enriching soils
112-7 provide examples of how science and technology associated with soil enrichment affects their lives
113-7 suggest solutions to problems or issues related to soil use and misuse

Lesson Activity Overview
The focus of this lesson is for students to have discussions about how adding things to soil can have affects. There are positives and negatives to each. It is suggested that each outcome be treated as a conversation that students have. For each there should be reflection to assess learning.

Composts, manure, and chemical fertilizers may be addressed when looking at ways to enrich soils. Students who have composters at home can describe what they do with the composted material. It is not necessary to delve into the chemical nutrients of soils and the various soil deficiencies. It is sufficient to note that some of the organic material is either leached out or utilized by other living things such as plants and soil-living organisms.
Students should investigate and discuss various positive and negative effects and intended and unintended consequences of enriching soils. For example, fertilizer usage on lawns and gardens can encourage growth of certain plant species, but it can also discourage the growth of other plants that some organisms rely on. Enriching soils with commercial chemical fertilizers may help produce larger crop fields in the short term, but may also harm the soil if used at the expense of regular crop rotation which naturally enriches the soils and provides humus to keep it more stable. A person using fertilizer to help crops to grow does not intend to have fish killed if the fertilizer is washed out of the soil and into a stream after a heavy rain.113-1

Task
Create an illustration of the various intended and unintended consequences of enriching soils. (113-1)

<u>Journal</u>
Explain a positive and a negative effect of enriching soils. For each identify if is an intended or unintended result.113-1

Our ability to enrich soils with a variety of fertilizers to grow more food than ever can be addressed. The energy expenditures required to enrich soils can be explored. Farmers using organic and chemical methods to enrich soils can be invited to class to talk about their methods and procedures.112-7

Journal
Research which foods are able to be grown in your region because of our ability to enrich soils. (112-7)

Students should be encouraged to investigate, debate, and discuss the use and misuse of soil in their region or in the context of agricultural use and forestry practices. Students should learn to appreciate the delicate nature of soils when they are not used wisely or safeguarded from abusive practices. Students should come to realize that the loss of soil has an impact on humans in any given ecosystem. 113-7

Task (Students should choose one of the following tasks)
A. Identify examples of misuse of soil in your community. Present a sketch of the situations to your class. (113-7)

B. Write to an organization that is involved with the care and use of soils to find out what we can do to preserve soils in our region. (113-7)

Journal
Imagine you are a farmer. What measures would you employ to help reduce soil erosion? (113-7)

Assessment:Informal Formative
Ensure that student participate in discussion related to the effects of enriching soils 113-1, 112-7, 113-7)

Assessment:Formal Formative
Ensure that students have created a pictorial representation of various intended and unintended consequences of enriching soils. (113-1)

Ensure that students have created a journal entry that explain a positive and a negative effect of enriching soils. For each identify if is an intended or unintended result.113-1

Ensure that students have created a journal entry in which they Research which foods are able to be grown in your region because of our ability to enrich soils. (112-7)

Ensure that students have completed a task that highlights the use and misuse of soils in their community 113-7

Ensure that students have create a journal entry where they Imagine you are a farmer. What measures would you employ to help reduce soil erosion? (113-7)