

Unit 4

Earth's Crust

Suggested Time: 25 Hours

Unit Overview

Introduction

By the end of elementary grades, students have explored the components and differences between soils. They have also examined the differences between rocks and minerals and have looked at how rocks and minerals are important in our lives. This unit will extend students' understanding of rocks and minerals by looking at the processes that create the different types of rocks and how volcanoes and earthquakes shape Earth's crust. Students will learn more sophisticated ways of classifying both rocks and minerals as well as how the processes of weathering and erosion of rocks contribute to the formation of soils.

Focus and Context

This unit provides students with many opportunities to engage in inquiry and to practice numerous scientific processes. Through labs and hands-on activities students engage in observing, classifying, reporting, analyzing, predicting, planning, and interpreting. Where possible, field trips to and examples from the local environment should be used to reinforce the various concepts encountered in this unit. Group work and research projects can be used to further investigate the importance of the concepts learned in class to the local area.

Science Curriculum Links

In primary, students explored the composition of soils. In elementary grades, they looked at factors that caused changes in the landscape and the relationship between rocks and minerals. In this unit, students will learn about the processes that create the various types of rocks. They will also develop a deeper understanding of the importance of rocks, minerals, and geologic processes. This will provide a sound basis for further study of earth science at the high school level where students may choose to learn more about Earth systems, Earth resources, Earth processes, and historical geology.

Curriculum Outcomes

STSE	Skills	Knowledge
<p><i>The student will be expected to</i></p> <p>Nature of Science and Technology</p> <p>109-2 describe and explain the role of collecting evidence, finding relationships, proposing explanations, and imagination in the development of scientific knowledge</p> <p>109-7 identify different approaches taken to answer questions, solve problems, and make decisions.</p> <p>110-1 provide examples of ideas and theories used in the past to explain natural phenomena.</p> <p>110-3 identify major shifts in scientific world views.</p> <p>110-4 describe examples of how scientific knowledge has evolved in light of new evidence.</p> <p>110-5 illustrate examples of conflicting evidence for similar scientific questions.</p> <p>Relationships Between Science and Technology</p> <p>111-2 provide examples of technologies used in scientific research.</p> <p>Social and Environmental Contexts of Science and Technology</p> <p>112-3 explain how society's needs can lead to developments in science and technology</p> <p>112-7 provide examples of how science and technology affect their lives and their community.</p> <p>112-12 provide examples of Canadian contributions to science and technology.</p>	<p><i>The student will be expected to</i></p> <p>Initiating and Planning</p> <p>208-2 identify questions to investigate arising from practical problems and issues.</p> <p>208-8 select appropriate methods and tools for collecting data and information and for solving problems.</p> <p>209-4 organize data using a format that is appropriate to the task or experiment</p> <p>209-1 carry out procedures controlling the major variables.</p> <p>209-3 use instruments effectively and accurately for collecting data.</p> <p>209-4 organize data using a format that is appropriate to the task or experiment.</p> <p>Analyzing and Interpreting</p> <p>210-1 use or construct a classification key.</p> <p>210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots.</p> <p>210-6 interpret patterns and trends in data, and infer and explain relationships among the variables.</p> <p>210-11 state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.</p> <p>Communication and Teamwork</p> <p>211-2 communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means.</p>	<p><i>The student will be expected to</i></p> <p>310-1 describe the composition of Earth's crust.</p> <p>310-2 classify rocks and minerals based on their characteristics and method of formation.</p> <p>310-3 classify various types of soil according to their characteristics, and investigate ways to enrich soils.</p> <p>311-1 explain the processes of mountain formation and the folding and faulting of Earth's surface.</p> <p>311-2 explain various ways in which rocks can be weathered.</p> <p>311-3 relate various meteorological, geological and biological processes to the formation of soils.</p> <p>311-4 examine some of the catastrophic events, such as earthquakes or volcanic eruptions, that occur on or near Earth's surface.</p> <p>311-5 analyze data on the geographical and chronological distribution of catastrophic events to determine patterns and trends.</p> <p>311-6 develop a chronological model or time scale of major events in Earth's history.</p>

Rocks and Minerals

Outcomes

Students will be expected to

- classify minerals based on their physical properties (210-1, 310-2a)

- define mineral

- list and describe properties of minerals. Include:

- (i) colour
- (ii) streak
- (iii) lustre
- (iv) hardness
- (v) cleavage
- (vi) fracture

Elaborations—Strategies for Learning and Teaching

Using a KWL chart teachers could explore their students' background knowledge on minerals by asking them to list various minerals that they have seen or have used in their everyday life. Teachers may wish to note to students that there are hundreds of different minerals on our planet.

Students should recognize that a mineral is a pure, naturally occurring, inorganic solid substance.

Teachers should stress that not all mineral properties are equally reliable for identification purposes. For example, quartz and feldspar can come in a variety of colours. Quartz can be milky white, smokey grey and even a light red or pink. Feldspar can be pink, white or blue. Students should be made aware that in order to correctly identify minerals, more than one property must be observed.

Students should recognize that streak is a more reliable characteristic for mineral identification than colour. For example, hematite may occur in a variety of colours but will always have a reddish-brown streak. It is not necessary for students to memorize Moh's hardness scale, however, there is an opportunity for teachers to use a mnemonic device as a learning strategy. The Moh's Hardness Scale can be remembered using the line: The Good Cop From Avondale Fought Quickly To Catch Dave.

Rocks and Minerals

Tasks for Instruction and/or Assessment

Paper and Pencil

- Given several pairs of minerals that look similar, write a note to another student describing several tests that may help differentiate them. (210-1, 310-2a)
- Students can choose a mineral and show all its properties by creating a brochure or poster display (210-1, 310-2a)

Journal

- If you were given an unknown mineral sample and could only use one property to describe it, which would you use and why. (210-1, 310-2a)
- Can ice be classified as a mineral? (310-2a, 210-1)

Resources/Notes

Rocks and Minerals (continued)

Outcomes**Students will be expected to**

- use a mineral classification key to investigate questions arising from practical problems (208-2, 210-1)
- select appropriate methods and tools for collecting and organizing data to identify minerals (208-8, 209-4)

- using a classification key, identify common minerals. Include: (210-1)
 - (i) quartz
 - (ii) calcite
 - (iii) magnetite
 - (iv) mica
 - (v) pyrite
 - (vi) galena
 - (vii) gypsum
 - (viii) talc
 - (ix) feldspar
 - (x) hematite

Elaborations—Strategies for Learning and Teaching**Core Laboratory Activity: A Mineralogist's Mystery.**

The Laboratory Outcomes 208-2, 208-8, 209-4, 210-1 and, in part, 310-2a are addressed by completing CORE LAB 10-1c “A Mineralogist's Mystery”.

In the Core Lab, students will be involved in using a classification key to identify minerals using the physical characteristics of streak colour, lustre, and hardness (refer to identification key). Other properties of minerals that students may observe include magnetic quality, cleavage and fracture

Depending upon local availability, other specimens may be added to this list. Although students should be able to use a classification key to identify minerals, it is not necessary for them to memorize specific characteristics of individual minerals.

Rocks and Minerals (continued)

Tasks for Instruction and/or Assessment*Performance*

- Use streak plates to determine the streaks left by mica, quartz, calcite, etc., and produce a table that communicates your findings. (210-1, 310-2a)
- Using a number of minerals with which to do scratch tests, determine the relative hardness of the minerals using the Mohs' scale. (210-1, 310-2a)
- Using a dichotomous key, classify minerals by their physical characteristics. (210-1, 310-2a)
- Using vinegar, perform the acid test on a variety of minerals to observe effervescence. (210-1, 310-2a)

Resources/Notes

Rocks and Minerals (continued)

Outcomes

Students will be expected to

- classify rocks based on their characteristics and method of formation: (310-2b)

- define rock

- define igneous rock and describe their formation

- differentiate between magma and lava

- differentiate between intrusive and extrusive igneous rocks using examples. Include:

- (i) granite (intrusive)
 - magma
- (ii) basalt (extrusive)
 - lava

- relate crystal size in igneous rocks to rate of cooling

Elaborations—Strategies for Learning and Teaching

Students should be encouraged to propose questions that could lead to investigations about how the main families of rock types form. Questions such as “How do the crystals or minerals form in a rock?” or “Why do some rocks have layers?” or “Why do some rocks have rounded particles as opposed to angular particles?” could be investigated as an introduction. When discussing examples of the three rock types, teachers should use actual samples.

Students could create a mind map at this point. The center would be “Earth’s Crust”. The first branch could be labelled “Rocks & Minerals”.

Students should define a rock as a combination of two or more minerals.

Students should understand that igneous rocks result from the cooling of molten material. As this material cools, crystals are formed. A sub-branch could be added to the mind map and labelled “Igneous Rocks”.

Students should be able to identify molten material below the surface is referred to as magma and molten material on the surface is referred to as lava.

Students should understand that igneous rocks form both at the surface of the Earth and below it. Those that form above are referred to as extrusive (formed from lava) while those that form below are referred to as intrusive (formed from magma). Students could note that granite and basalt are two of the most common igneous rocks found in the Earth’s crust. Teachers could include additional examples of extrusive rocks such as obsidian and rhyolite or intrusive rocks such as gabbro.

Students should be able to identify that the longer magma/lava has to cool, the larger and more organized the crystals in the rock. Conversely, the shorter the cooling time, the smaller the crystals will be.

Teachers could demonstrate the effect of cooling rate on crystal size using stearic acid, copper (II) sulfate, or Epsom salts and associate this with the formation of crystals and igneous rocks. To vary the cooling rates, cool one sample in a freezer and leave the other to cool at room temperature. To ensure crystal formation, the solutions used should be super-saturated.

Rocks and Minerals (continued)

Tasks for Instruction and/or Assessment

Paper and Pencil

- Explain how crystal size and/or shape in rocks may help to describe its origin. (310-2b)
- Construct a table to show how the three types of rock differ in formation and texture. (310-2b)
- Sketch several outcrops (rock cuts on the side of a road) in your region to show the types of rocks present around you. (310-2b)

Journal

- “Questions a person could ask in order to investigate differences in rocks are....” (310-2b)
- Create a list of 5-10 questions one could ask in order to investigate differences in rocks. (310-2b)

Performance

- Use a magnifying glass to determine if certain igneous rocks are intrusive or extrusive. (310-b)
- Draw sketches that demonstrate how baking cookies in an oven represents what happens to mineral crystals in sedimentary and igneous rocks when they are subjected to great heat. (310-2b)
- Write a song that describes the 3 rock families and how they form. (310-2b)
- Prior to learning about the 3 families of rocks, students could be given a variety of rock samples and asked to classify into 3 groups. After the three families are taught, students could return to the rock samples and reclassify. (310-2b)

Resources/Notes

Classification of Rocks

Outcomes

Students will be expected to

- classify rocks based on their characteristics and method of formation: (310-2b)

(continued)

- define sedimentary rocks and describe their formation

- list and show examples of sedimentary rocks. Include:
 - shale (small particles)
 - sandstone (medium particles)
 - conglomerate (large particles)
 - limestone (plant and animal particles)

- define metamorphic rock

- describe the formation of metamorphic rocks

Elaborations—Strategies for Learning and Teaching

Students should recognize that sedimentary rocks form from the compaction and cementation of sediments into visible layers called beds.

Teachers could demonstrate sedimentation using a large glass jar containing water and sediments of various grain sizes.

Students could replicate the process of compaction by stacking three different colored balls of play-dough between two sheets of aluminum foil. They would then apply various amounts of pressure to simulate the creation of sedimentary rocks (pressed between the hands). Students could note that the colour of the dissolved mineral that cements the sediments together may determine the color of the sedimentary rock formed. They could also note the compaction process by observing that the pore spaces between the layers becomes smaller and smaller as pressure is applied.

Teachers should note that sedimentary rocks are classified by grain size. Teachers should explain that shale has the smallest particles (silt or mud size), sandstone (sand particles – those that can roll between your fingers) and conglomerate (gravel).

Students could add another sub-branch for “Sedimentary Rocks” to their mind map to summarize what they have learned about this class of rocks.

Students should recognize that metamorphic rocks result when preexisting rocks (parent rocks) undergo changes due to heat and pressure.

Students should be able to distinguish between the formation of metamorphic rock and igneous rock. When melting occurs the reformed rock will be igneous.

Classification of Rocks

Tasks for Instruction and/or Assessment

Paper and Pencil

- Using pictures of vertical cuts through snow banks, show how the formation of snow banks from snowfall events is similar to the formation of sedimentary rocks by sedimentation. (310-2b)

Performance

- Create a model to show the formation of metamorphic rock from its parent rock (e.g., limestone to marble, shale to slate, granite to gneiss, etc.) (310-2b)
- Given an unknown rock sample, use a classification key to identify. (310-2b)

Resources/Notes

Classification of Rocks (continued)

Outcomes

Students will be expected to

- classify rocks based on their characteristics and method of formation: (310-2b)

(continued)

- list examples of metamorphic rocks and their parent rock. Include:
 - (i) slate from shale
 - (ii) marble from limestone
 - (iii) quartzite from sandstone
 - (iv) gneiss from granite

Elaborations—Strategies for Learning and Teaching

These examples include sedimentary rocks (shale, limestone and sandstone) and igneous rocks (granite) that change to metamorphic rocks. Other local examples may be included.

Students could add the third sub-branch to their mind map to summarize “Metamorphic Rocks”.

Teachers could use a summary activity to classify rocks into their respective families.

Teachers could have students engage in a Quiz-Quiz-Trade activity to review the terminology and differences between the three families of rocks.

Classification of Rocks (continued)

Tasks for Instruction and/or Assessment*Presentation*

- Students could research the various metamorphic rocks found in their area and present to the class. (310-2b)

Paper and Pencil

- Students could create Quiz-Quiz-Trade cards for the terms up to this point. (310-2b)

Resources/Notes

Rock Cycle

Outcomes

Students will be expected to

- identify questions to investigate arising from the study of the rock cycle (208-2)

- sketch and label a diagram of the rock cycle

- recognize the relationship between various types of rocks (igneous, sedimentary, metamorphic)

Elaborations—Strategies for Learning and Teaching

The rock cycle, like any natural cycle, represents a change process where the same materials are cycled throughout, producing different products under varying conditions. The materials found in rocks undergo constant change to produce new types of rocks under different conditions.

Students should not be expected to replicate the rock cycle diagram from the textbook in its entirety. However, given a framework, students should be able to label missing information.

Students should follow arrows in the Rock Cycle diagram and should be expected to know how one type of rock can be changed to form another. For example, to form igneous rock from sedimentary rock, the sedimentary rock has to be changed to metamorphic rock first, then melted to form magma and then cooled to form igneous rock. Students could produce their own rock cycle diagram to support their learning. Students could be asked to bring in one or more samples of local rocks and examine them in order to identify any similarities and differences in them. Students could examine common rocks such as sandstone, shale, basalt, granite, gneiss and slate. Students could be asked to compare the sample rocks and attempt a personal classification based on their differences and similarities.

Students could do a 2-minute review on this topic.

Rock Cycle

Tasks for Instruction and/or Assessment

Paper and Pencil

- How is the rock cycle similar to the recycling of matter? (208-2)

Presentation

- Create a display to show the differences of how the three main rock types are formed. (310-2b)
- Create a poster display showing the 3 rock families with examples and an explanation of their formation (pictures or drawings). (208-2, 310-2b)
- Create a collage of the different rocks found in our everyday life. (200-2, 310-2b)
- Create a multimedia presentation of the rock cycle. (208-2)

Journal

- Write the diary of a blob of magma which cools to form igneous rock, is then exposed to weathering and erosion on the Earth's crust to form sediments, then compacted and cemented to form sedimentary rock, then metamorphosed by heat and pressure, then melted to reform magma. (208-2, 310-2,)

Resources/Notes

Structure of the Earth

Outcomes

Students will be expected to

- describe the characteristics of Earth's crust and some of the technologies which have allowed scientists to study geological features in and on the earth's crust (109-7, 111-2, 310-1)

- sketch and label a model of Earth's layered interior.

Include:

- inner core
- outer core
- mantle
- crust

- recognize that Earth's crust is broken into plates and movement occurs where plate margins meet (plate tectonics)

Elaborations—Strategies for Learning and Teaching

This section provides an excellent opportunity for teachers to include treatment of the Nature of Science. In particular, teachers could include some of the following points relative to the Nature of Science:

- While it may take a great deal of time, scientific ideas are subject to change over time as new observations and interpretations are made. New ideas are sometimes rejected in favor of the prevailing theories, even when there is overwhelming evidence supporting the new ideas.
- Scientists are human, with all the faults that implies (stubbornness, jealousy, pride, etc).
- The often held view of scientists, as lab coat-wearing men who toil away isolated in an office or laboratory, is far from reality. There are both male and female scientists. Some work mainly in laboratory settings but many work out of doors. Some collect samples and make observations that they will study more carefully when they get back to their laboratory.

Teachers could use an orange, a boiled egg, or a peach to illustrate the structure of Earth. If using a boiled egg, the shell would represent the crust, the white of the egg represents the mantle, while the yolk represents the inner and outer core. This analogy can be further developed when discussing crustal plates by simply cracking the egg. The sections of shell would represent the various plate and the cracks would be the boundaries

Students will use this model of Earth's interior later in this unit to explain why plates move and the features of the crust that result from this movement. It is important for students to know the relative position and size of the layers, qualitatively only. Note that the inner core is solid and is made mostly of nickel and iron. The outer core is liquid and is made mostly of nickel and iron. The mantle is partly molten. Students could add another branch to their mind map and call it "Earth's Crust".

A common misconception is that the crustal plates correspond to the continental boundaries. To dispel this misconception, teachers could conduct a jig-saw-puzzle activity in which the crustal plates are the pieces of the puzzle, but drawn on the puzzle pieces are the continents, or parts of continents, that are on these plates. This would help students to understand that the plates carry not only land masses but also oceanic crust.

Structure of the Earth

Tasks for Instruction and/or Assessment

Resources/Notes

Paper and Pencil

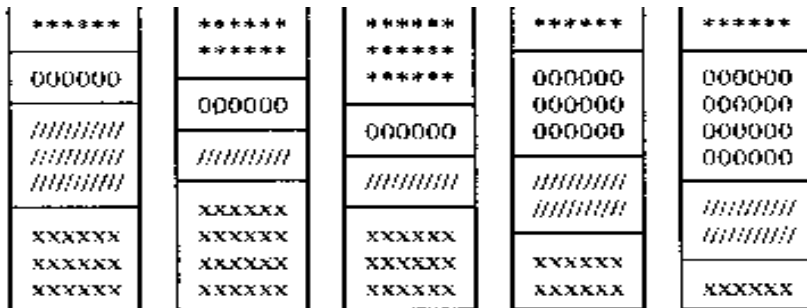
- Draw a pie graph to show the abundance of various minerals in Earth's crust. (109-7, 111-2, 310-1)

Presentation

- Research and give a presentation on a technology used to study geological features and resources. (109-7, 111-2, 310-1)

Performance

- Create a series of “collector cards” (like hockey cards) for the different layers of the earth and the different minerals. Include a picture or diagram on one side and on the other side put the characteristics. (109-7, 310-1)



- You are given these pictorial representations of five core samples that were taken at equal intervals over 100 metre distance (straight line). Draw the geological profile of the earth's crust for that 100 metre distance. (310-1)
- Use a model (e.g., hard boiled egg, apple, orange, etc....) to show the composition of Earth. Use a diagram to show how the model compares to the layers of Earth in terms of thickness and composition. (110-4)

Plate Tectonics Theory

Outcomes

Students will be expected to

- describe how plate tectonic theory has evolved in light of new geological evidence (110-4)
- identify Alfred Wegener as the person responsible for proposing the Continental Drift Theory
- describe the Continental Drift Theory and the evidence supporting it; Include evidence from:
 - (i) continental fit (paleogeographic)
 - (ii) fossils (biological)
 - (iii) rock layers (geological)
 - (iv) climate (meteorological)

Elaborations—Strategies for Learning and Teaching

Plate Tectonic concepts are explored in the STSE Module for this unit. Since students can choose to study this topic in more detail in Earth Systems 3209, teachers should limit discussion to highlight the main events in the development of the theory. Teachers should limit the number of examples used and focus on the evidence, not the detailed workings of the technologies used.

Students should recognize that Alfred Wegener's initial ideas were not globally accepted despite the evidence that seemed to support his theory. He couldn't identify the mechanism that caused the continents to move.

The concept that continents have moved relative to one another (called continental drift) and the early evidence that led to the development of the plate tectonic theory came to light at the beginning of the 1900's. Students should come to appreciate that mounting evidence from a variety of sources led to our present theory of plate tectonics. Paleogeographic evidence (South America and Africa seem to fit together), structure and rock type evidence (correlation of sequence of layers across the Atlantic), fossils from the Avalon Peninsula with those found in Wales (trilobites), and coal, which forms in warm climates, has been found in Antarctica are used in arguments for continental drift.

Students could do a Think-Pair-Share in which they consider the question: "Of the four pieces of supporting evidence (for Continental Drift Theory), which one do you think was the most important in supporting this Theory?"

Plate Tectonics arose from the earlier Continental Drift Theory in light of new evidence from technological advancements in data collection and Earth modeling.

Teachers could have students do a Quiz-Quiz-Trade activity to review and reinforce the terms and concepts covered to date.

Plate Tectonics Theory

Tasks for Instruction and/or Assessment

Paper and Pencil

- Prepare a time line that illustrates the evolution of our understanding of plate tectonic theory. (110-4)
- Why have dinosaur fossils been found in areas where they would not be able to live if they were alive today? (110-4)
- Trilobite fossils discovered along Manuels River in C.B.S., NL, are directly correlated to trilobite fossils found in Wales, UK. How does this support the theory of Continental Drift? (110-4)
- Draw a diagram to show how convection currents occur in the Earth's crust and how they cause plate movement. (110-4)
- Write two letters to the editor of a scientific newspaper. One letter should defend Alfred Wegener's theory of Continental Drift while the other should oppose his theory. Use scientific evidence for both arguments. (110-4)

Performance

- Use laminated cutouts of Earth's continents to create super continents. Display your results and provide your own names for the super continents. (110-4)
- Use the Internet to locate satellite images of plate margins. Locate one example of a divergent, convergent, and transform plate margins. (110-4)
- Float flat pieces of styrofoam in a pan of water. Heat gently on a hot plate. Describe how the styrofoam "plates" move with the convection currents. (110-4)

Resources/Notes

Plate Tectonics Theory (continued)

Outcomes

Students will be expected to

- describe how plate tectonic theory has evolved in light of new geological evidence (110-4)

(continued)

- identify the technological advances that have provided evidence to support the current theory of Plate Tectonics. Include:
 - sonar
 - magnetometers
 - deep sea drilling
- identify types of plate boundaries. Include:
 - divergent (pulling apart)
 - convergent (pushing together)
 - transform (sliding past)
- identify convection currents in the Earth as a possible explanation of the driving force mechanism behind plate tectonics

Elaborations—Strategies for Learning and Teaching

Students should have exposure to the ways in which geologists investigate and explore the Earth's crust by looking at some of the technologies used in gathering data about the Earth's crust. They could investigate technologies such as satellite imaging, seismographs, remote sensing, magnetometers, and core sampling.

Students should recognize that these technologies have allowed scientists to develop a more detailed picture of the interior of the Earth, thus supporting the Theory of Plate Tectonics. Sonar provided a more detailed picture of the sea floor, such as the mid-Atlantic Ridge; magnetometers provided evidence for sea floor spreading; and deep sea drilling provided evidence for the internal structure of the crust. Teachers should be aware of the evidence each of these technologies has provided, but it is not necessary to provide this information to students in any detail.

Teachers could use any type of student movement activity to simulate the movement of the crustal plates, for example, "The Plate Tectonic Jive" which would have students doing divergent, convergent and transform dance steps, set to music.

Students should come to realize that where crustal plates meet they can and do move in three main ways. Later in the unit students could relate crustal plate movement to mountain building processes, earthquakes and volcanoes. Students can explore plate movement at the PBS.org website.

Once students understand what happens at plate boundaries they can begin to investigate why this happens. Teachers should review convection currents remembering that this concept has been covered in more detail in the Heat unit.

Students should now be able to use their conceptual model of Earth's crust and mantle to recognize the connection between convection currents and plate movement. The source of energy that creates the heat that drives these convection currents is thought to be the result of intense pressure.

Plate Tectonics Theory (continued)

Tasks for Instruction and/or Assessment

Paper and Pencil

- Research a Canadian geologist and report on his/her contribution to the theory of plate tectonics. (112-12)

Journal

- Do mountains grow? Why or why not? (110-4)

Presentation

- Create a presentation that outlines Wegner's contribution to the theory of Continental Drift. (110-4)

Performance

- Dramatize an interview with one of the listed Canadian geologists. (112-12)
- Dramatize a debate between Alfred Wegener and his opponents. (112-12)
- Create a model that demonstrates the three types of plate movement. (110-4)
- Devise a set of hand gestures to illustrate the three types of plate movement. (110-4)

Resources/Notes

Plate Tectonics Theory (continued)

Outcomes

Students will be expected to

- provide examples of Canadian contributions to our understanding of local, regional, and global geology (112-12)
- describe how our explanations of how the Earth has changed over time is based on the collection of evidence and finding relationships between various observations in imaginative ways (109-2)
- describe how our understanding of the forces that shaped our Earth have changed over time as new evidence was collected (110-5)
- identify the Theory of Continental Drift as one early explanation for how our Earth changed over time (110-1)
- identify the Theory of Plate Tectonics as an example of a major shift in our world view (110-3)

Elaborations—Strategies for Learning and Teaching

Students should be able to identify the following Canadian scientists and list one of their contributions to geologic findings. Include:

A) J. Tuzo Wilson

Proposed a third type of plate movement where plates slide past each other along what he called transform boundaries.

B) Joseph Tyrell

Discovered dinosaur fossils in Alberta, which proved that the local climate was warmer at an earlier time.

C) Harold Williams

Highlighted the plate tectonic activity that occurred regionally along the eastern edge of the North American continent.

The **CORE STSE** component of this unit incorporates a broad range of Grade 7 Science outcomes. More specifically, it targets (in whole or in part) 109-2, 110-1, 110-3, 110-5 and 310-1. The STSE component, “Seeing the Big Picture”, can be found in Appendix A. Teachers should engage students in discussion of the Nature of Science as they address these outcomes.

In particular, teachers should include some of the following points relative to the Nature of Science:

- Our physical world operates in consistent patterns that are understandable through careful and systematic study/observation. Through the use of our intellect, and with the use of instruments to improve our observations, we can discover the patterns in nature.
- While it may take a great deal of time, scientific ideas are subject to change over time as new observations and interpretations are made. New ideas are often rejected in favour of the prevailing theories, even when there is overwhelming evidence supporting the new ideas.
- Scientists are human, with all the faults that implies (stubbornness, jealousy, pride, etc). This is the main reason why new ideas, based on empirical evidence, are often rejected when they first appear.
- The stereotypical view of scientists, as lab coat-wearing men who toil away isolated in an office or laboratory, is far from reality. There are both male and female scientists. Some work mainly in laboratory settings but many work out of doors. Some collect samples and make observations that they will study more carefully when they get back to their laboratory.

Plate Tectonics Theory (continued)

Tasks for Instruction and/or Assessment*Paper and Pencil*

- Write a letter from Wegener to a friend in which he describes his/her theory of how the continents came to be as they are today. (110-5)

Journal

- “The main differences between what Wegener and Wilson believed are....” (110-4)

Presentation

- Students could research the life and times of Wegener and present to the class. (110-4)
- Create a skit in which Wegener and J. Tuzo Wilson meet and discuss their beliefs of how the continents formed. (110-4, 112-12)

Resources/Notes

Earthquakes, Volcanos and Mountains

Outcomes

Students will be expected to

- examine some of the catastrophic events, that occur on or near Earth's surface.
(311-4) Include;
 - (i) earthquakes
 - (ii) volcanic eruptions

- define earthquake

- explain why earthquakes occur using the concept of plate tectonics

Elaborations—Strategies for Learning and Teaching

Unlike most geological processes, earthquakes and volcanoes generally occur over a short period of time and are readily observable. This topic could begin with a general discussion about these phenomena. Opening questions such as, “Do we experience volcanoes and earthquakes in our region?”, and “Is there evidence for these types of geological processes in our region?” would allow for an assessment of students’ prior knowledge as well as motivate the students to begin considering these topics in light of their immediate environment. Students could view videos or use computer software to see actual scenes of volcanoes and earthquakes in the process of occurring and discuss the effects that they have on local environments.

A simple definition is all that is required here. Students should define an earthquake as “the shaking of the Earth”.

In the discussion, teachers could mention that the seismograph is the device used to record earthquakes. Teachers could demonstrate the working of a seismograph by moving a piece of paper under a stationary pencil. Students could also be encouraged to design and create their own seismograph.

Teachers could also expand the discussion to mention that the Richter Scale is the method used to describe earthquake strength. The higher the number, the stronger the quake, thus the more potential for damage.

Students should recognize that earthquakes are the result of energy released from forces built up due to plate tectonics (plate movement) in Earth’s crust. When this energy is released, it travels in wave form known as seismic waves.

Seismic events do occur in our region and these events, although usually minor, are unpredictable and potentially damaging. As an example, teachers could highlight the tsunami that struck the Burin Peninsula in 1929. Earthquakes in this area occur due to movement along more local faults on the floor of the Atlantic Ocean making them more sporadic events.

Teachers could demonstrate the concept of seismic waves by dropping a pebble into a container of water. Alternatively, teachers could ask students to visualize what happens when a rock is thrown into a still body of water. The circular waves that move from the centre are analogous to seismic waves.

Earthquakes, Volcanos and Mountains

Tasks for Instruction and/or Assessment

Paper and Pencil

- Write a report that compares volcanos and earthquakes. (311-4)
- How are sound waves and seismic waves similar? (311-4)
- How are the waves formed on water from throwing a rock similar to seismic waves? (311-4)
- How does distance from the epicentre influence the readings on the Richter scale? (311-4)
- Research the strongest earthquakes that have occurred on Earth since 1990. Draw a bar graph to show the difference in magnitude among these earthquakes from lowest to greatest. (311-4)
- Why is a very low tide an indication that a tsunami is about to occur? (311-4)

Journal

- How would you prepare for a tsunami? (311-4)

Presentation

- Prepare a poem or a song in which volcanos and earthquakes are compared and contrasted. (311-4)
- Create a multimedia presentation on the evidence of volcanic activity in Newfoundland and Labrador. (311-4)
- Create a 3-D model of a volcano to illustrate how it can become a mountain.

Performance

- Make a home made seismograph to illustrate how the strength of an earthquake is determined. (311-4)
- Place a glass bowl of water over two pieces of wood which are positioned side by side. Describe what happens when you slide the wood back and forth. How does this represent how earthquakes are created? (311-4)
- Use the Internet to locate satellite images of volcanos formed at convergent zones, divergent zones, and hot spots. (311-4)

Resources/Notes

Earthquakes, Volcanos and Mountains (continued)

Outcomes

Students will be expected to

- examine some of the catastrophic events that occur on or near the earth's surface (311-4)

(continued)

- define volcano.
- identify how and where volcanoes form. Include
 - areas where plates converge
 - areas where plates diverge
 - areas where plates are thin (hotspots)

- organize and analyze data on the geographical distribution of earthquakes and volcanoes to determine patterns and trends (209-4, 210-6, 311-5)

Elaborations—Strategies for Learning and Teaching

Students should define that a volcano as an opening in the Earth's crust. An introduction to volcanoes could include videos, pictures, or web sites of the Mount St. Helens eruption, or any other volcano.

Students should understand that there are several environments where volcanoes occur most often:

- Where plates collide at convergent boundaries, intense pressure can melt rock that later flows to the surface as a volcano (the Pacific Ocean is being subducted under Japan).
- Where plates separate, at divergent boundaries, molten rock flows up to the surface (mid-Atlantic Ridge).
- Where plates are thin, magma can be forced up through the cracks to the surface (Hawaiian Islands).

Volcanic events do occur on our continent and these events are unpredictable and can cause great damage. Scientists can predict that a dormant volcano will erupt but not with any real accuracy. Teachers could present video material or Internet information on the Mount St. Helens volcanic eruption that occurred in 1980 in the United States.

Teachers should provide students with information about the location and dates of major earthquakes and volcanoes in recorded history. Students could record the data on a world map. In this way, students can examine the relationship between the location of these events and the major geological plates. Students could identify the Pacific Rim, also known as the "Ring of Fire", from their organization and analysis of the data.

Teachers could have students complete Activity 11-2e "Patterns in Earthquake and Volcano Locations", to address or reinforce these outcomes.

Earthquakes, Volcanos and Mountains (continued)

Tasks for Instruction and/or Assessment

Resources/Notes

Paper and Pencil

- Draw a table to show the difference between the tsunamis that occurred on the Burin Peninsula of Newfoundland and Labrador in 1929 and the one that occurred in south Asia on December 26, 2004. (311-4)
- Research the environmental effects of a volcano on the surrounding ecosystems. (311-4)
- Research how Iceland and the Hawaiian Islands formed? (311-4)

Performance

- Compare satellite imagery of the Pacific Ring of Fire with a map of plate boundaries in the area. (209-4, 210-6, 311-5)
- Use electronic software (e.g., Google Earth) to locate images of the following geological features: (i) volcano (e.g., Mount St. Helen's), (ii) fault (e.g., San Andreas Fault), (iii) mountain ranges (e.g., Himalayans)
- Choose a particular region prone to earthquakes. Show the frequency and intensity of the quakes in a bar or line graph. (209-4, 210-6, 311-5)
- Given the latitudes and longitudes of certain earthquakes, plot their locations on a world map and compare the pattern of earthquakes with plate boundary locations. (311-4)

Earthquakes, Volcanos and Mountains (continued)

Outcomes

Students will be expected to

- provide examples of theories used in the past to explain volcanic activity, earthquakes, and mountain building (110-1)
 - identify explanations of volcanic and earthquake activity from the past.

Include:

 - (i) Pele
 - (ii) Glooscap
- explain the processes of mountain formation (311-1)
 - define folding and faulting.
 - explain how mountains are formed using the theory of Plate Tectonics

Include:

 - (i) folding
 - (ii) faulting
 - (iii) volcanic eruption

Elaborations—Strategies for Learning and Teaching

Teachers should briefly outline the prior theories related to mountain building, volcanoes and earthquakes.

Different cultures throughout history have had ideas and explanations about the origins and causes of volcanic and earthquake activity and mountain formation. Teachers could emphasize that this is part of science; observations are made about happenings in the world and people try to explain the sources or causes of those events.

When a formal study and explanation of the observations are made, it may be considered a theory. That “theory” may be revised as new observations are made or may even be dismissed completely. Students could be challenged to investigate a particular group or culture. 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)
- Anaxagoras (Greek who believed that volcanic eruptions were caused by great winds within the earth)
- René Descartes (French philosopher who believed an incandescent earth core was the source of volcanic heat)

Students could observe maps of continents and ocean basins that contain ocean ridges and major structural features as well as observe and interpret that the puzzle pieces have natural boundaries formed by these features.

Students should define folds as bends in the rock layers and faults as breaks in rocks layers.

Models, videos and local pictures could be used to have students explore and understand these processes. Modelling clay of various colors can be used to represent layers of the Earth’s crust. By pushing together the ends of the modelling clay, students could observe the effects of pressure on forming a fold. Models of faults can also be made in this way but it is important to note that faults involve breaking, thus the material used must be more brittle.

Students should be able to relate that lava, ashes and cinders from an active volcano can build up and form a mountain. The volcano Paricutin, a famous example that occurred in a farmer’s field in Mexico, is now several hundred meters high.

Teachers could have students engage in a Quiz-Quiz-Trade activity to review the terms and concepts covered to date.

Earthquakes, Volcanos and Mountains (continued)

Tasks for Instruction and/or Assessment

Resources/Notes

Presentation

- 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)
- Complete a webquest on the topics of volcanos, earthquakes and mountain building using Canadian Earth Science Internet sites. (112-12, 311-4)
- Create a layered cross-section of the Earth's crust out of soft Styrofoam sheets and demonstrate faulting and folding. (311-1)
- Create a 3-D model of a volcano to illustrate how it can become a mountain.

Portfolio

- Create a time line that illustrates the development of the theory of plate tectonics. (110-1)

Paper and Pencil

- Write a newspaper article that announces the development of plate tectonic theory and how it explains the formation of mountains. (311-1)
- In a written report, describe the relationships between plate boundaries, mountain building and trenches. (311-1)
- Investigate how people in the past explained catastrophic events such as volcanos and earthquakes. (110-1)

Geological Time Scale

Outcomes

Students will be expected to

- develop a chronological model or geological time scale of major events in Earth's history (209-4, 311-6)

- describe the geologic time scale in terms of the four main eras and the major events that occurred in each. Include:
 - (i) Precambrian – formation of the Earth and appearance of simple life forms
 - (ii) Paleozoic – appearance of more complex life forms
 - (iii) Mesozoic – appearance and extinction of dinosaurs
 - (iv) Cenozoic – appearance of humans

Elaborations—Strategies for Learning and Teaching

Students should begin to appreciate the magnitude of time involved in most geological processes and events. Students could prepare and construct their own life time scale and compare it to a geological time scale. To introduce this topic, students could be shown how major groups of organisms (reign of the dinosaurs) fit into specific time periods defining that period of time. Boundaries ending one era and beginning another reflect major geologic events such as the extinction of the dinosaurs. Teachers could support the concept of geologic time by selecting students as particular organisms and placing them in a relative position along a corridor wall on a time scale.

Students should identify the four main eras and one main event that occurred in each. Teachers should continue to emphasize the magnitude of geological time and stress to students that human existence on Earth represents a very small proportion of that geological time. Students could construct a time line diagram that would enable them to visualize both the order and duration of events in geological time.

Teachers could create, or have students create, a physical model to help students understand the large numbers involved. This could take the form of a 4.6 m length of calculator tape or paper towel with each meter representing 1 billion years. In this model 4.01 m would represent the Precambrian Era.

Teachers could have students measure the length of a school corridor or gym floor. The distance could be divided to represent the four Eras of Geologic time.

It is important that students understand the vast span of time represented by the Precambrian and that much of that time was practically lifeless. Our knowledge of geologic time after the Precambrian is directly linked to fossil evidence reflective of that time.

Teachers could present material to enrich students' appreciation for geological time by showing how fossil evidence supports the evolution from the beginning of life in the Precambrian to present day.

Some students may have already collected fossil specimens that may be placed along a time line. The Government of Newfoundland and Labrador, Department of Natural Resources (Geological Survey) provides educational support regarding fossils on their website.

Geological Time Scale

Tasks for Instruction and/or Assessment

Paper and Pencil

- Why is there little fossil representation in the Precambrian rock record? (209-4, 311-6)

Presentation

- Create a poster display showing the four main eras and major events that occurred in each era. (209-4, 311-6)
- Create a physical scale model that shows the respective amounts of time covered by each era. Indicate the major events at each time period. (209-4, 311-6)

Performance

- Research and prepare a report that compares and contrasts the dominant animals and plants in each era of geologic time. (311-6)
- Produce a chronological time scale of some major events in human history and compare it to Earth's history. (209-4, 311-6)
- Create a pictograph that shows the difference in geologic time of era, periods, and epochs. (209-4, 31-6)

Resources/Notes

Weathering and Erosion

Outcomes

Students will be expected to

- explain various ways in which rocks can be weathered and eroded to form soils (311-2, 311-3)

- define weathering

- identify types of weathering
Include:
 - (i) mechanical
 - (ii) chemical

Elaborations—Strategies for Learning and Teaching

Students should be encouraged to consider and propose questions related to the break up or weathering of rocks on or near the earth's surface. Weathering and erosion (concepts introduced in the elementary grades) are important components of the rock cycle. Questions such as, "Are there different ways in which rocks can be weathered?", and "How long does it take to weather some types of rocks?", could be used to further investigate the phenomena of weathering.

Students should define weathering as the mechanical and/or chemical breakdown of rock. Rocks are exposed to the forces of weathering when at or near the surface of the earth.

Students should identify mechanical weathering, as the physical breakdown of rocks into smaller fragments. The most common type of mechanical weathering is frost wedging. Students should be encouraged to think of examples in which they have seen the action of ice and frost in producing broken rocks. Local cliffs or sea shore embankments are good locations to find this type of weathering. The movement of plants (roots) and animals (worms, rodents, ants) cause rock to be mechanically weathered.

Students should identify chemical weathering, as chemical reactions that break down rocks. Students could 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 that live on rocks such as lichens can cause chemical weathering. Students may be able to describe rocks or headstones in their community that are being weathered in this way.

Students could make a journal entry discussing examples of mechanical and chemical weathering they see in their local environment.

Weathering and Erosion

Tasks for Instruction and/or Assessment

Presentation

- Research and report on how some structures made of rocks (pyramids, statues, and gravestones) are changed by weathering and erosion. (311-2)
- Create a visual display that distinguishes the two types of weathering. (311-2)

Portfolio

- Imagine you are a writer for a scientific magazine. Write a short article describing how a mountain can be weathered and eroded and how the sediments can create new sedimentary rocks. (311-2)

Paper and Pencil

- Is there a relationship between the amount of weathering on a graveyard headstone and the age of the headstone ? (311-12)
- Use diagrams to describe the processes involved in moving material from a mountain to the bottom of a river over time. (311-12)
- How are weathering and erosion harmful to life on Earth? (311-12)
- How are weathering and erosion harmful to life on Earth? (311-12)
- Research the amount of money spent each year in Newfoundland and Labrador for repairing roads that are damaged as a result of weathering. (311-12)

Resources/Notes

Weathering and Erosion (continued)

Outcomes

Students will be expected to

- explain various ways in which rocks can be weathered and eroded to form soils (311-2, 311-3)

(continued)

- define Erosion

- identify the various agents of erosion Include:
 - (i) water in motion
 - (ii) meteorological processes (rain and wind)
 - (iii) geological processes (gravity and glaciers)

- differentiate between weathering and erosion

Elaborations—Strategies for Learning and Teaching

Students should understand that erosion is the process that loosens and moves weathered rock particles (sediment) over Earth’s surface.

Teachers should cover these briefly to give the context for differentiating between weathering and erosion.

Local examples of water as both a weathering and erosion agent allow students to better understand water as the most powerful of geological forces. Teachers could use a stream table to illustrate the concept of erosion.

Students should recognize that erosion means that sediments are being moved. Weathering does not involve movement.

Soil

Outcomes

Students will be expected to

- classify various types of soil according to their characteristics. (310-3)

Include:

- coarse-textured (sandy gravel) soil
- medium-textured (loamy) soil
- fine-textured (clay) soil

- define porosity and permeability

- relate porosity and permeability to soil types

Elaborations—Strategies for Learning and Teaching

Teachers should clarify that eroded minerals form the basis of soils. The combination of eroded minerals and decaying plant and animal materials forms a soil.

The soil type that forms depends on the rock type that is being weathered. For example, when shale is weathered, clay type soil results.

Students should recognize that the classification of soils is generally based on the textured qualities or how they feel.

Soils differ in organic matter, parent soil material and the amount of air and water they contain. Students should be able to classify and describe sandy/gravel soils, loamy soils and clay soils. Coarse-textured soils feel gritty, and may roll between your fingers, and students might be able to identify the small grains using the naked eye. Clay soils feel greasy, like toothpaste, with very little texture, especially when wet. A loamy soil is composed of sand, silt and clay in nearly equal proportions and has various textures depending on the percentages of their composite parts.

Students should define porosity as is the amount of empty space in a 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 should determine how much water is required to saturate a soil sample (porosity) and drip through in a given amount of time (permeability). Teachers could ask students to reflect on the types of vegetation associated with the different soil types.

Teachers could have students do a Quiz-Quiz-Trade activity to review to this point.

Soil

Tasks for Instruction and/or Assessment

Performance

- Given a variety of soil types, classify them as closely as possible, in the three main types. (310-2)

Paper and Pencil

- Research methods used to make soils economically valuable (i.e., fertilizers, screening, sand for cement, road building, etc....) (310-3)
- Research the location of agricultural areas on Earth and describe the types of soil present in each. (310-3)
- Give three examples of how the type of soil determines the type of plants present. (310-3)

Presentation

- Research and write a report on how soils are maintained and fertilized in your region. (310-3)

Interview

- Interview an engineer to explain how soil properties are important in building large structures such as bridges. (310-3)

Portfolio

- Interview a farmer or agricultural technician to find out about the soil types in your region and what grows best in them. (310-3)

Resources/Notes

Soil (continued)**Outcomes****Students will be expected to**

- carry out procedures controlling the major variables to answer questions arising from practical issues (208-2, 209-1)
- use instruments effectively and accurately for collecting data (209-3)
- compile, organize and display data, using a tabular format (209-4, 210-2, 211-2)
- interpret patterns and trends in data, and infer and explain relationships among the variables (210-6)
- state a conclusion, based on experimental data, and explain how the data gathered supports or refutes an initial idea (210-11)

Elaborations—Strategies for Learning and Teaching**Core Laboratory Activity: Be a Soil Sleuth.**

The Laboratory outcomes 208-2, 209-1, 209-3, 209-4, 210-2, 210-6, 210-11 and, in part, 310-3 are addressed by completing CORE LAB 12-2b “Be a Soil Sleuth”.

Soil (continued)

Tasks for Instruction and/or Assessment*Performance*

- Design a fair test to identify soils based on their porosity and permeability. (209-1)

Observation

- Design a fair test for determining soil properties. (209-1)

Resources/Notes

